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ARD

Summary Booklet

Agriculture Extensions:		
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Ecology and Climate Change:		
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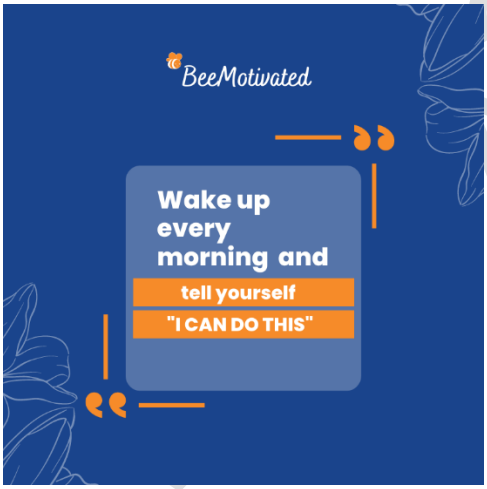
Important Points: -

- In the course, every topic is covered individually in short videos, notes and chapter tests, follow the approach for detail of the topic.
- This document is kind of summary document, it covers tentative syllabus for conceptual agriculture provided by NABARD in the notification.
- Syllabus is given for Phase 2 only based on that you can prepare for phase 1 also as there is no separate syllabus.
- Revise regularly, for any doubt and query ask faculty in the live class.
- Must join live classes regularly.
- Visit your course regularly for the updates.



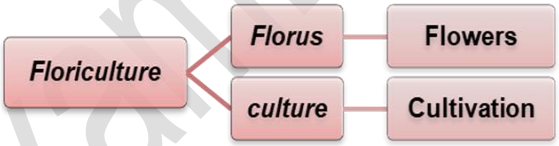
General Agriculture

1. Definition, meaning and its Branches

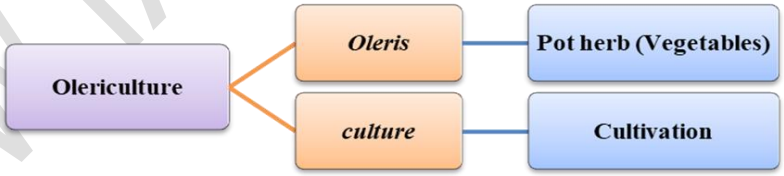
- **Agriculture:** The word 'Agriculture' is derived from the **Latin** word **'Ager'** means **Land or field** and **'Culture' means cultivation**. It means the **science and Art of producing crops** and livestock for economic purposes. Agriculture is an art of raising plant life from the soil for the use of mankind

- **Agronomy:** word drive from **two Greek word "Agros"** means field and **"Nomos"** means to manage. "It is defined as an agricultural science that deals with principles and practices of crop production and field management".
  Or "Agronomy is a branch of agricultural science, which deals with principles, & practices of soil, water & crop management".

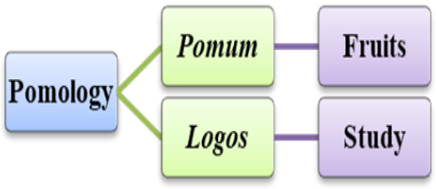
- **Horticulture:** word drive from two **Latin** word **"Hortus"** means **garden and "cultura/ Cultus" means cultivation.** "Horticulture is a branch of agriculture in which deal fruit crops, vegetable crops, ornamental plants, commercial flower, medicinal crops, aromatic crops, spices crops, plantation crops, individual tree, shrub, climber and post-harvest management and processing".
  - **Floriculture-** Derived from two words "Flor" means flower and "cultura" means cultivation. A branch of horticulture that deals with the culture and management of flowers and ornamental plants.



  - **Olericulture-** The science and practice of growing, handling, storing, processing and marketing of vegetables.



  - **Pomology:** The branch of horticulture, concerned with the production, harvesting, processing, preservation, storage and marketing of fruits and nuts.



- **Entomology**: The term entomology is derived from two Greek words. **Entomon Means an insect and logos means to study.** Entomology is the study of Insects.

- **Apiculture:** Apiculture word drive from **two Latin words**. It is a branch of agriculture in which deal study of beekeeping and honey production.

- **Sericulture:** Sericulture word drive from **two Latin words**. It is a branch of agriculture in which deal study of Silkworm (Bombyx mori) domestication and silk production.

- **Lac Culture**: The English word lac synonyms Lakh in Hindi which itself is derivative of Sanskrit word Laksh meaning a lakh or hundred thousand. It is a branch of agriculture in which deal study of **Lac insect (Laccifer lacca) domestication and lac production.**

- **Plant Pathology: -** The study of plant diseases is called plant pathology. Pathology is derived from the **two Greek words pathos (suffering, disease) and logos (discourse, study).** Plant pathology thus means a study of plant diseases and their management.

- **Animal husbandry:** word drive **from "Animal" and "Husband" words**. Animal means livestock and husband means one who takes care. "Animal husbandry is the branch of agriculture concerned with animals that are raised for meat, fiber, milk, eggs, or other products. It includes day-to-day care, selective breeding, and the raising of livestock".

- **Forestry:** Forestry word drive from French **"Forest" word means wooded country**. "Forestry is defined as the theory and practice of all that constitutes the creation, conservation and scientific management of forests and the utilization of their resources (Anon, 1966). It includes all thinking and all actions pertaining to creation and management of forests, including harvesting, marketing and utilization of all forest products and services. **It includes not only management of existing forests but also the creation of new forests".**

- **Fisheries:** Aquatic and fisheries science is the study of aquatic ecosystems to increase scientific understanding and to apply basic ecological principles to their management, thereby sustaining them for multiple uses.

- **Agricultural Engineering:** It is the branch of engineering involved with the design of **farm machinery, with soil management, land development, and mechanization and automation** of livestock farming, and with the efficient planting, harvesting, storage, and processing of farm commodities.

- **Home Science:** Home Science can be defined as the multidisciplinary field of study that deals with health, diet, caring child, textile and garment designing, managing resources and other subjects concerned with a home.

2. Agronomy: definition, meaning and scope of agronomy.

- This term is derived from **Greek words "agros" meaning "field" and "nomos" meaning "to manage".**
- **Definition** – It is defined as an agricultural science which deals with principles and practices of soil, water and crop management.
- It is the branch of agricultural science that deals with methods which provide favorable environment to the crop for higher productivity.
- Agronomy is a synthesis of several disciplines like soil science, crop physiology, plant ecology, entomology, agricultural chemistry, plant pathology and plant ecology.
- Soil physical, chemical and biological properties have to be understood thoroughly to affect the modification of the soil environment.
- It is also necessary to understand crop physiology to meet their requirements.
- **Father of Agronomy –** Pietro Decrescenzi

Scope of Agronomy-

- Agronomy is a dynamic discipline.
- With the advancement of knowledge and better understanding of plant and environment, agricultural practices are modified or new practices are developed for **high productivity**.
- As the population pressure increasing, intensive cropping is the need of the day and proper time and **space intensification** is required not only to increase production but also reduces **the environmental hazards**.
- Identification **of proper season for cultivation of wide range of crops** is needed which could be made possible only by agronomy science.
- Proper methods of cultivation are required to reduce the cost of cultivation**, maximize yield and economic returns.**
- Water management practices play an important role in present day crisis of water demand and agronomy science deals with water management practices during critical stages of crop to ensure better growth and fulfil crop water demand.

Study under Agronomy

- Growth and development of crops:
- Soil environment and its modification:
- Seed and sowing
- Mineral Nutrition:
- Water management:
- Weed management
- Cropping systems:
- Harvesting and storage

3.Classification of field crops. Factors affecting crop production

Based on season: -

Kharif	Rabi	Zaid
Term "Kharif" means **Autumn in Arabic.**	Term "Rabi" means **Spring in Arabic.**	Term 'Zaid' means **summer in Arabic**
Kharif crops are sown in the **beginning of rainy season** (South west monsoon) i.e. June – July and harvested in the month of October.	Rabi crops are sown in the **month of October – November** (During North West Monsoon) and harvested in the month of February.	Sown in **March and harvested in May**
Crops of this season are also known as **Monsoon crops**	Crops of this season are known as **Winter crops**.	**Summer Crops**
Paddy, Maize, Soybean, Sorghum, Groundnut, Cotton and some pulses are Kharif crop	Wheat, Chick Pea, Pea, Sunflower, Safflower, Mustard etc	Paddy (Summer Rice), Groundnut, Moong, Sunflower, Maize, Cucurbits.

On the basis of botany: -

- **Cereal Crops**- Belongs to family Gramineae, these are grasses grown for edible grain. E.g., - wheat, rice, sugarcane, maize, jowar, millets, etc.
- **Pulse Crops**- Pulses are crops of Leguminosae family, these are usually grown as rainfed. Pulses are grown in both *Rabi* and *Kharif* season. E.g., - Pigeon pea, chickpea, lentil, mungbean, urdbean, etc.
- **Millet Crops-** These are minor cereals, usually grown in rainfed areas and arid reasons in scarcity of water since water requirement of millets is very low. E.g., -Foxtail millet.
- **Edible Oilseeds-** Crops which are used for extracting edible oil for. E.g., - Groundnut, Mustard and Rapeseed, Sunflower, Sesame etc. Groundnut and Rapeseed mustard provide 66% of total oilseed production.
- **Fiber Crops**-These crops are used to extract fiber. E.g., – Cotton, Jute, Sun hemp, etc.
- **Forage crops**-These crops are used for animal feed. E.g., – Lucerne, Oats, Berseem etc.
- **Sugar crops-**Sugar is extracted from these crops. E.g., –Sugarcane and Sugar beet.
- **Aromatic crops**-Essential oils and Aromatic compounds are extracted from these crops. E.g., - Lemon grass, Mentha etc.

Factors affecting crop production

- **Internal Factors (Genetic factors)**
  - High yielding ability: -
  - Early maturity (Days after sowing)
  - Quality of grains
  - Tolerance to biotic and abiotic stresses
- **External factors (Environmental factors)**

Climatic factors

- Precipitation (Rainfall)
- Temperature
- Atmospheric humidity (Relative Humidity)
- Solar radiation

Edaphic factors (Soil factors)

- Soil moisture
- Soil mineral matter
- Soil organic matter
- Soil organisms
- Soil reactions

Biotic factors

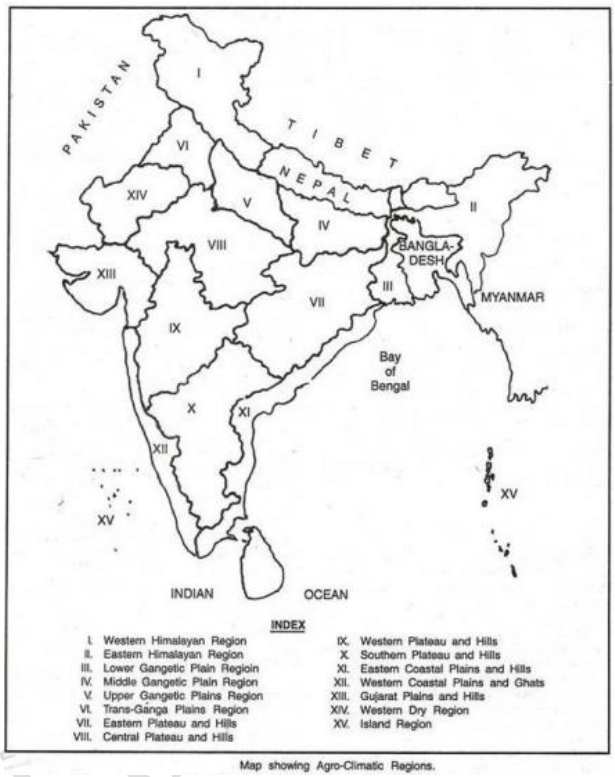
- Insect pest
- Weeds
- Animals

Physiographic factors

Socioeconomic Factor

4. Agro Climatic Zones

- Food and Agriculture Organization (FAO) defined an agro-climatic zone (ACZ) as a land unit represented accurately or precisely in terms of major climate and growing period, which is climatically suitable for certain range of crops and cultivars. In other words, it is an extension of the climate classification keeping in view the suitability to agriculture.
- The Planning Commission has categorized 15 agro-climatic zones in India, taking into account the physical attributes and socio-economic conditions prevailing in the regions.



Map showing Agro-Climatic Regions.

I. **Western Himalayan Region**: The Western Himalayan Region covers Jammu and Kashmir, Himachal Pradesh and the hill region of Uttarakhand.

II. **Eastern Himalayan Region:** The Eastern Himalayan Region includes Arunachal Pradesh, the hills of Assam, Sikkim, Meghalaya, Nagaland, Manipur, Mizoram, Tripura, and the Darjeeling district of West Bengal.

III. **Lower Gangetic Plain Region:** West Bengal (except the hilly areas), eastern Bihar and the Brahmaputra valley lie in this region.

IV. **Middle Gangetic Plain Region:** The Middle Gangetic Plain region includes large parts of Uttar Pradesh and Bihar.

V. **Upper Gangetic Plains Region:** In the Upper Gangetic Plains region come the central and western parts of Uttar Pradesh and the Hardwar and Udham Nagar districts of Uttarakhand.

VI. **Trans-Ganga Plains Region**: This region (also called the Satluj-Yamuna Plains) extends over Punjab, Haryana, Chandigarh, Delhi and the Ganganagar district of Rajasthan.

VII. **Eastern Plateau and Hills:** This region includes the Chhotanagpur Plateau, extending over Jharkhand, Orissa, Chhattisgarh and Dandakaranya.

VIII. **Central Plateau and Hills:** The region is spread over Bundelkhand, Baghelkhand, Bhander Plateau, Malwa Plateau, and Vindhyachal Hills.

IX. **Western Plateau and Hills:** Comprising southern part of Malwa plateau and Deccan plateau (Maharashtra), this is a region of the regur (black) soil with July temperature between 24 °C and 41 °C, January temperature between 6 °C and 23 °C and average annual rainfall of 25 cm-75 cm.

X. **Southern Plateau and Hills:** This region falls in interior Deccan and includes parts of southern Maharashtra, the greater parts of Karnataka, Andhra Pradesh, and Tamil Nadu uplands from Adilabad District in the north to Madurai District in the south.

XI. **Eastern Coastal Plains and Hills:** In this region are the Coromandal and northern Circar coasts of Andhra Pradesh and Orissa.

XII. **Western Coastal Plains and Ghats:** Extending over the Malabar and Konkan coastal plains and the Sahyadris, the region is humid with the mean July temperature varying between 25 °C and 30 °C and mean January temperatures between 18 °C and 30 °C.

XIII. **Gujarat Plains and Hills:** This region includes the hills and plains of Kathiawar, and the fertile valleys of Mahi and Sabarmati rivers.

XIV. **Western Dry Region:** Extending over Rajasthan, West of the Aravallis, this region has an erratic rainfall of an annual average of less than 25 cm. The desert climate further causes high evaporation and contrasting temperatures—28 °C to 45 °C in June and 5 °C to 22 °C in January.

XV. **Island Region**: The island region includes Andaman-Nicobar and Lakshadweep which have typically equatorial climate (annual rainfall less than 300 cm; the mean July and January temperature of Port Blair being 30 °C and 25 °C respectively).

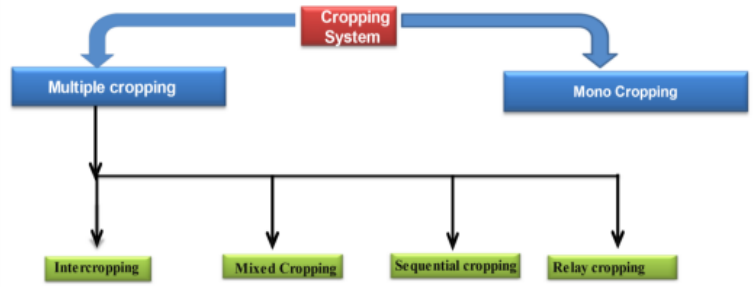
5.Cropping Systems: Definition and types of cropping systems.

Cropping Systems

- **Cropping pattern' and 'cropping system'** are two terms used interchangeably; however, these are two different concepts. While cropping pattern refers to the yearly sequence and spatial arrangement of crops or of crops and fallow in a particular land area; cropping system refers to cropping pattern as well as its interaction with resources, technology, environment etc.
- **cropping system** usually refers to a combination of crops in time and space. Combination in time occurs when crops occupy different growing period and combinations in space occur when crops are inter planted. When annual crops are considered, a cropping system usually means the combination of crops within a given year.
- **Cropping pattern-** the yearly sequence and spatial arrangement of crops or of crops and fallow on a given area. Cropping system - The cropping patterns used on a farm and their interaction with farm resources, other farm enterprises, and available technology which determine their makeup.

Cropping System- Cropping Pattern + Management

- **Type of Cropping System**



- **Mono cropping**- Growing of single crop in same land year after year Or Monocropping is the agricultural practice of growing a single crop year after year on the same land.
- **Cropping intensity of monocropping is also 100%**

- **Multiple cropping:** The intensification of cropping in time and space dimensions. Growing two or more crops on the same field in a year.
    - Growing two or more crops on the same field in a year.
    - Annual and perennial plants can be organized in fields together.
    - It is a form of polyculture
- **Intercropping**- Intercropping is the cultivation of two or more crops at the same time on the same field. The most common goal of intercropping is to produce a greater yield on a given piece of land by making use of resources that would otherwise not be utilized by a single crop.

Types of intercropping

- **Parallel cropping -** Cultivation of such crop which have different natural habit and Zero competition. · Ex: - Maize + Greengram/ Urdbean
- **Companion cropping** - When the production of both inter crops is equal to that of its solid planting. Ex: - Mustard/ onion + sugarcane
- **Multi-storeyed cropping -** Cultivation two or more crops of different heights simultaneously on the same field. Ex: - Coconut + Black pepper + Banana
- **Synergetic cropping**- This type of cropping yield of both the crops are higher than their pure crops on per unit area. Ex: - Sugarcane + Potato

Mixed cropping

- Growing of two or more crops simultaneously on the same piece of land, without any definite row arrangement.
- This system of cropping is practiced in areas where climatic hazards such as flood, drought, frost etc are frequent and common. The farmers always fear that their crops will fail.
- Mixed cropping is also practiced with a view to achieve multiple requirements of food and fibre.

Based on method of sowing mixed cropping can be classified into the following groups

Mixed crops –

- In this case, the seeds of different crops are mixed together and then sown either in lines or they are broadcasted.
- The system is not scientific and it causes problems in performing all the agricultural operations and harvesting of the crops.

Companion crops –

- Under this method the seeds of different crops are not mixed together but different crops are sown in different rows i.e. between two rows of mustard five to eight rows of wheat or between two rows of arhar two three rows of groundnut are sown.
- This method of sowing facilitates in weeding, intercultural, plant protection operation and even in harvesting.

Guard crops –

- Under this system of cropping, the main crops is grown in the center, surrounding by hardy or thorny crops such as safflower around pea or wheat, around sugarcane, jowar around maize etc with a view to provide protection to the main crop.

Augmenting crops –

- When sub crops are sown to supplement the yield of the main crop, the sub crops are called as augmenting crops such as Japanese mustard with berseem. Here the mustard helps in getting higher tonnage of fodder in spite of the fact that berseem gives poor yield in first cutting.

Sequential cropping

- Growing two or more crops in sequence on the same field in a farming year.
- The succeeding crop is planted after the preceding crop has been harvested.

Relay intercropping

- Relay intercropping or relay cropping is a system in which a second crop is planted into an existing crop when it has flowered (reproductive stage) but before harvesting.
- There is thus a minimum temporal overlap of two or more crops. The relay crop should be fairly tolerant to shade and trampling.
- Examples of relay crops are cassava, cotton, sweet potato and sesbane with corn; chickpea, lentil and wheat with upland rice.

6. Classification of farming based on Rainfall.

Dryland Agriculture- Dryland Agriculture refers to growing of crops entirely under rainfed conditions.

Based on the amount of rainfall received, dryland agriculture can be grouped into three categories:

Dry farming, Dryland farming and Rainfed farming

Particulars	*Dry farming*	*Dryland farming*	*Rainfed farming*
Rainfall/ annum (mm)	<750	750-1150	>1150
Moisture availability	Acute shortage	Shortage	Enough
Crop growing season	<75 days	75-120 days	>120 days
Growing region	Arid	Semi-arid	Humid
Cropping systems	Single crop/ Inter cropping	Single crop/ Intercropping	Intercropping/ multicropping
Dry spells	Most common	Less frequent	No occurrence
Crop failure	More frequent	Less frequent	Rare
Constraints	Wind erosion	Wind erosion/ Water erosion	Water erosion
Measures required	Moisture conservation practices	Moisture conservation practices and drainage for vertisols	Proper drainage

7. Problems of dryland agriculture

- Inadequate and uneven distribution of rainfall
- Late onset and early cessation of rains
- Prolonged Dry spells during the crop period
- Low moisture retention capacity
- Low Fertility of Soils
- Socio- economic constraints
- Technological and developmental constraints
- Limited infrastructure development and unproper/ untimely availability of credits and agricultural inputs.

8. Seed production, seed processing, seed village

- Seed is a fertilized matured ovule together covered with seed coat is called seed or it is a propagating material.

Seed Production

- Any material used for planting or propagation, it may in the form of seed (grain) seedlings, tubers, bulbs, rhizomes, roots, cuttings, grafts or any other vegetative propagated material.

Classes of Seed

- Nucleus Seed
- Breeder Seed
- Foundation Seed
- Certified Seed

	Nucleus Seed	Breeder seeds	Foundation Seeds	Certified Seed
Produced from	Nucleus stock	Nucleus Seed	Breeder Seed	Foundation Seed.
Produced By	Original breeder/Institute/State Agriculture University (SAU)	Department of Agriculture and Cooperation (DOAC), Ministry of Agriculture, Government of India, under supervision of plant breeder / institute / SAUs	Seed Producing agencies in public and private sectors	supervision of Seed Certification Agencies.
Scale	Small scale multiplication.	large area as per indent	Large Scale Multiplication	Large Scale Multiplication
Color tag		Golden Yellow color	White Color	Azur Blue color

General Standards

Component	Breeder Seed	Foundation seed	Certified Seed
Genetical Purity	100%	97-98%	98%
Physical Purity	100%	>95%	>90%
Min. Germination	100%	70-85%	60-80%
Max. Inert Matter	0%	2%	2%

Two types of seeds according to freezing

- **Orthodox Seeds**
- **Recalcitrant Seeds (Unorthodox Seeds).**
- **Intermediate Seeds**

Orthodox seeds

- Seeds which can be dried down to a low Moisture Content of around 5% to 10% and successfully stored at low or sub- freezing temperatures for long periods.
- Orthodox seeds are seeds which will survive drying and/or freezing during ex-situ conservation.
- Examples-nPea, Tomato, Corn, Guava, Sapota, Banana, Apple, Cherry, etc.

Recalcitrant seed

- Seeds which cannot survive drying below a relatively high moisture content (30–50%) and which cannot be successfully stored for long periods.
- Recalcitrant seeds are seeds that do not survive drying and freezing during ex-situ conservation.
- Examples- Jamun, Jackfruit, Mango, Litchi, Mangosteen, Durian, Avocado, Citrus, Rambutan, etc.

Intermediate seeds

- Which exhibit the drying tolerance characteristic of the orthodox seeds but are sensitive to low temperature storage like the recalcitrant seeds.
- Examples- Papaya, Macadamia nut

Isolation Distance- Isolation distance is the minimum separation required between two or more varieties of the same species for the purpose of keeping seed pure.

Seed Processing

- After harvest the seeds need to be processed by various methods in order to maintain the physical purity and also to increase the shelf life. This should be done before seeds are taken for storage.
    - Cleaning
    - Winnowing
    - Sieving
    - Drying

Seed Village

- A village, where group of farmers are trained and included in production of seeds of various crops to cater the needs of themselves, fellow farmers of the village and farmers of neighboring villages at appropriate time and at affordable cost is called “a seed village”.

Concept of Seed Village

- To organize seed production in clusters or a compact area
- To replace existing local varieties with new high yielding varieties
- To increasing the seed production
- To meet the local demand, timely supply of seed at reasonable cost
- To ensure social and economic self-sufficiency and self-reliance of the village
- To increase the seed replacement rate (SRR)
- The implementing agencies are State Departments of Agriculture, State Agriculture Universities, Krishi Vigyan Kendras, State Seeds Corporation, National Seeds Corporation, State Farms Corporation of India (SFCI), State Seeds Certification Agencies, and Department of Seed Certification.
- State Government and the implementing agencies will have to identify the areas of better seeds production and a compact area approach needs to be followed under this programme.
- Suitable responding/willing minimum 50 farmers for same crop will be identified/selected preferably in compact area/cluster approach in consultation with the concerned State Department of Agriculture by the implementing agencies.
- The number of farmers may be more than 50 also subject to a maximum of 150.

9. Meteorology: weather parameters, crop-weather advisory

- **Meteorology -**Meteorology term derived from two Greek words, **'Meteoros'** means **'above earth surface (atmosphere)' and 'logy' means 'science'**.
- It is the branch of physics which deals with physical process in the atmosphere that produce weather
- **Agrometeorology-** It deals with the response of crops to the physical environment.
- **Climatology-** It deals with the factors which determine and control the distribution of climate over earth's surface.
- **Agroclimatology-** It deals with the relationship of climate regimes and agricultural production.
- **WMO – World Meteorological Organization**
  - Established in 1950
  - Headquarters are in Geneva, Switzerland.
  - It is originated from the International Meteorological Organization (IMO), founded in 1873.
- **IMD – Indian Meteorological Department**
  - It was established in the year 1875 with its headquarters at Calcutta. The headquarter was shifted to Shimla in 1905, to Pune in 1928 and then to Delhi in 1944.
  - Presently, it headquarters is in New Delhi.

Difference between Weather and Climate:

Weather	Climate
State or condition of atmosphere at a given place and at a given time, daily variation or conditions of lower layer of the atmosphere. Examples: rainy day, hot day, cloudy weather or dry weather, etc.	Summation of weather conditions over a given region during a comparatively longer period Examples; tropical climate, temperate climate, etc.

- **Atmosphere:**
  - It is a gaseous envelope of invisible film that surround the earth.
  - Extends up to a height of about 1600 km.

Structure of atmosphere:

- Based on the vertical temperature difference, it is divided into 4 layers.
  - Troposphere
  - Stratosphere
  - Mesosphere

    - Thermosphere
- **Instruments of Agrometeorological laboratory and their uses: Instruments Uses/Measures**
    - Altimeter- Height
    - Aneroid barometer- Atmospheric pressure Anemometer- Wind speed / Velocity
    - Atmometer- Leaf temperature
    - Auxanometer- Growth of plants
    - Crescograph- Growth of plants
    - Hygrometer/Psychrometer- Relative humidity
    - Evaporometer- Evapotranspiration
    - Heliograph- Duration of bright sunshine hours
    - Lysimeter- Evapotranspiration
    - Pycnometer- Soil specific gravity
    - Porometer- Transpiration rate (ET)
    - Pyranometer- Total incoming solar radiation
    - Rain gauge- Amount of rainfall
    - Spectrophotometer- Wavelength of light
    - Tensiometer- Soil moisture tension
    - Wind vane- Wind direction

10. System of Crop Intensification

- Crop intensification is increase in agricultural productivity per unit of input use.
- Various input includes land, seed, labour, fertilizer, cultural operation cost and most importantly time.
- Main objective of crop intensification is to maximize output (yield) with minimum expenditure of capital and less use of water, labour and on monetary inputs.
- System of crop intensification includes multiple cropping, inter-cropping, mixed cropping, ratoon cropping, etc.

Need for System of Crop Intensification: -

- To increase the productivity per unit area in unit time and for amount of unit resources used.
- Traditional cropping system needs to be improved with time, based on changing environmental conditions, soil, climate, and water availability by keeping available resources and growing population in mind for efficient use.
- The cropping system should be integrated in such a way so that to provide round the year income to sustain the livelihood of farmers and maintain sustainability.
- One such example of crop intensification is SRI (System of Rice Intensification)
- It was developed in **1983 by Father Henri de Laulanié in Madagascar**.
- SRI concepts and practices have continued to evolve with time as they are being adapted to various environments with different climatic habits and with transplanting being sometimes replaced by direct-seeding.
- It is an agro-ecological technique to increase the productivity of irrigated rice by changing the management of soil, plants, nutrients and water.
- More outputs from less inputs.
- By transplanting 8-10 days old young seedlings, to preserve subsequent growth potential and plant one seedlings per hill and in a square pattern (25x25 cm), or wider only when the soil is more fertile.
- Transplant the seedlings quickly within 15 – 30 minutes after removing from the nursery.
- Shallow planting (1-2 cm deep) with moist soil but not continuously saturated so that there should be prevalence of mostly aerobic soil conditions.
- Weeding should be done to control weeds by a mechanical hand weeder.

Organic farming

- As per the definition of the **United States Department of Agriculture (USDA)** “Organic farming is a system which avoids or largely excludes the use of synthetic inputs (such as fertilizers, pesticides, hormones, feed additives etc.) and to the maximum extent feasible rely upon crop rotations, crop residues, animal manures, off-farm organic waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection”.

- **FAO suggested** that "Organic agriculture is a unique production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity, and this is accomplished by using on-farm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs."
- **According to IFOAM**, Organic Agriculture is a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic Agriculture combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and good quality of life for all involved.

Four Principles of Organic Agriculture: Health, Ecology, Fairness and Care

Advantages of organic farming

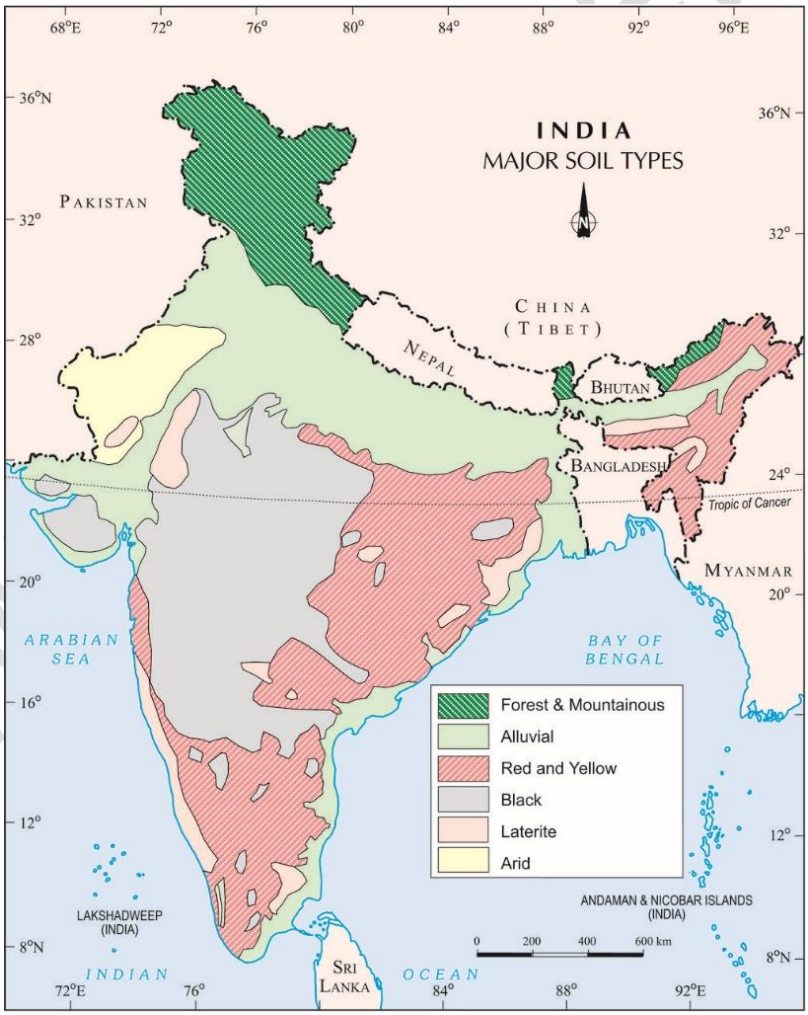
- It helps to maintain environment health by reducing the level of pollution.
- It reduces human and animal health hazards by reducing the level of residues in the product.
- It helps in keeping agricultural production at a sustainable level.
- It reduces the cost of agricultural production and also improves the soil health.
- It ensures optimum utilization of natural resources for short-term benefit and helps in conserving them for future generation.
- It improves the soil physical properties such as granulation, good tilth, good aeration, easy root penetration and improves water-holding capacity and reduces erosion.
- It improves the soil's chemical properties such as supply and retention of soil nutrients, reduces nutrient loss into water bodies and environment and promotes favorable chemical reactions

Soil and Water Conservation:

1. Major soil types and classification

The Indian council of Agricultural Research (ICAR) set up an All-India Soil Survey Committee which divided the Indian soils into eight major groups

1. Alluvial soils
2. Black (or Regur soil)
3. Red soils
4. Laterite soils
5. Arid and desert soil
6. Saline and alkaline soils
7. Peaty and marshy soil
8. Forest and mountain soils



Types of Soils	States	Rich in	Lack in	Crops grown
Alluvial	Mainly found in the plains of Gujarat, Punjab, Haryana, UP, Bihar, Jharkhand, etc.	Potash and Lime	Nitrogen and Phosphorous	Large variety of rabi and kharif crops such as wheat, rice, sugarcane, cotton, jute etc.
Black (Regur soil)	Deccan plateau Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh, Tamil Nadu, Valleys of Krishna and Godavari.	Lime, Iron, Magnesia and Alumina, Potash	Phosphorous, Nitrogen and organic matter	Cotton, sugarcane, jowar, tobacco, wheat, rice etc.
Red Soil	Eastern and southern part of the deccan plateau, Chhattisgarh and southern parts of the middle Ganga plain, Orissa	Iron and Potash	Nitrogen, Phosphorous and humus.	Wheat, rice, cotton, sugarcane and pulses
Laterite	Karnataka, Kerala, Tamil Nadu, Madhya Pradesh, Assam and Orissa hills.	Iron oxide and potash	Organic matter, Nitrogen, Phosphate and Calcium	Cashew nuts, tea, coffee, rubber
Arid and Desert	Western Rajasthan, North Gujarat and southern Punjab	Soluble salts, phosphate	Humus, Nitrogen	Only drought resistant and salt tolerant crops such as barley, rape, cotton, millets maize and pulses
Saline and Alkaline	Western Gujarat, deltas of eastern coast, Sundarban areas of West Bengal, Punjab and Haryana	Sodium, Potassium, Magnesium	Nitrogen and Calcium	Unfit for agriculture

2. Soil fertility and fertilizers

Soil fertility

- "It is the inherent capacity of the soil to provide all the essential plant nutrients in available form in adequate amount".

Soil Productivity

- "It is the capacity of soil to produce crops with specific systems of management and is expressed in yields".

C:N ratio

- It is defined as the ratio of the weight of organic carbon to the weight of total nitrogen in a soil or organic matter.
- It is the relationship between organic matter and nitrogen content of soils or plants. • C:N ratio is used to predict the rate of decomposition.
- It is important in controlling the available nitrogen.
- C:N ratio of 10:1 means there are ten units of carbon for each unit of nitrogen in the soil.
- C:N ratio of arable soils is 8:1-15:1, a little variation is due to climatic conditions like temperature and rainfall.
    - If C:N ratio >30 Immobilization occurs.
    - C:N ratio is 15-30 Immobilization and mineralization both occurs.
    - C:N ratio is <20 mineralization occurs.

Mineralization of Organic Nitrogen:

- Conversion of organic nitrogen (unavailable) to nitrate form (available).
- There are 3 steps involved: -
    1) **Aminization:** - Hydrolytic decomposition of protein and release of amines and amino acids by heterotrophs (bacteria like Bacillus, Pseudomonas) in the absence of oxygen.
    2) **Ammonification:** - The amines and amino acids so released are further utilized by other heterotrophs by release of ammoniacal compounds in the absence of oxygen.
    3) **Nitrification: -** Conversion of ammoniacal compounds into nitrite and then nitrate by autotrophs in the presence of oxygen.

Nitrogen losses: -

- **Volatilization:** - when pH is above 8, nitrogen is lost in the form of NH_3 in alkaline medium. • Chemical decomposition: - When pH is ≤5.5 under aerobic condition, chemical decomposition of nitrite takes place into nitrogen and nitrogen oxide.
- **Microbial denitrification**: - Formation and loss of gaseous form of nitrogen by biological reduction of nitrate and nitrite is known as denitrification.
- If the soil is very wet, less oxygen is available. When the soil is waterlogged, the soil microbes will find another source for the oxygen. The soil microbes will strip the oxygen from the nitrate molecule. With the oxygen stripped from the nitrate, the remaining nitrogen is lost as a gas.

- **Leaching: -** When water passes through soil, nitrate is moved below the root zone where it cannot be utilized by crops. This is especially a problem in areas that have both sandy soils and high rainfalls.

Fertilizers

- Organic and Inorganic materials of natural or synthetic origin which are added to the soil to supply nutrients essential for plant growth.

Classification of Fertilizers

- **Straight Fertilizers** – Fertilizers which contain only one primary nutrients. E.g., Urea.
- **Binary fertilizers** - Contains two major nutrients. E.g., Potassium nitrate.
- **Ternary fertilizers** - contains three major nutrients. E.g., Ammonium potassium sulphate.
- **Complete fertilizers** – Fertilizers having all three major nutrients viz. N, P & K.
- **Mixed fertilizers**- straight fertilizers are blended together physically to permit application in the field in one dose. Such fertilizers mixture supply two or three major nutrients in a definite proportion. E.g., Nitro phosphate with potash.
- **Complex Fertilizers** – Such fertilizers contain more than one major nutrient elements obtained chemically and generally in granular form. E.g., DAP, Ammonium Phosphate.
- **Low Analysis Fertilizers** – Contains less than 25 percent of primary nutrients. E.g., SSP (16%), Sodium Nitrate (16%).
- **High Analysis Fertilizers** – Contains more than 25 percent of primary nutrients. E.g., Urea (46% N), DAP (18% N & 46% P).
- **Fertilizer Grade**: - It refers to guaranteed analysis of its plant nutrients. It is the minimum guarantee of the plant nutrient contents in terms of N, available P_2O_5, K_2O. Example, 6:24:24
- **Fertilizer Ratio:** - refers to the relative percentage of N, P, K i.e. 1:4:4 if the fertilizer grade is 6:24:24.

3. Soil erosion and types

- **Soil Erosion-** Soil erosion is the displacement of the upper layer of soil, one form of soil degradation.
- This natural process is caused by the dynamic activity of erosive agents, that is, water, ice (glaciers), snow, air (wind), plants, animals, and humans.
- In accordance with these agents, erosion is sometimes divided into water erosion, glacial erosion, snow erosion, wind (aeolean) erosion, zoogenic erosion, and anthropogenic erosion.
- It is a process in which the top fertile layer of soil is lost. Due to soil erosion, the soil becomes less fertile. The top layer of soil is very light which is easily carried away by wind and water. The removal of topsoil by the natural forces is known as soil erosion.
- The process of soil erosion is made up of three parts:
    - **Detachment:** This is when the topsoil is actually "detached" from the rest of the ground.
    - **Movement:** This is when the topsoil is relocated to another area.
    - **Deposition:** Where the topsoil ends up after this process.

Major Causes of Soil Erosion

- **Wind-** When strong winds blow, the topsoil along with the organic matter is carried away by the wind. This happens more often when the land is not covered with grass or plants. Such conditions are very common in desert and semi-desert regions where strong winds blow very frequently.
- **Water-** When it rains in the hilly areas, the soil gets washed away towards the plains. The running water deposits the mineral-rich soil in the riverbed and over the years this deposition of soil can change the course of the river. This can lead to floods which cause the destruction of life and property. Water erosion leads to loss of agriculture potential.
- **Overgrazing-** When cattle are allowed to graze on the same field repeatedly, all the available grass, including the roots are eaten by them. This makes the topsoil vulnerable to wind and flowing water, leading to soil erosion.
- **Deforestation-** Humans have taken land from the forest to cultivate in order to feed the ever-increasing population and to build houses, industries, etc. Cutting down of trees on a large scale for these purposes is deforestation. The roots of trees hold the soil together, thus preventing the soil from getting uprooted. When large areas of the forest are cleared, the topsoil gets eroded by wind and flowing water.

Forms of Water Erosion

- **Sheet Erosion-** Sheet erosion is the movement of soil from raindrop splash and runoff water. It typically occurs evenly over a uniform slope and goes unnoticed until most of the productive topsoil has been lost. Deposition of the eroded soil occurs at the bottom of the slope or in low areas.

- **Rill Erosion-** Rill erosion results when surface water runoff concentrates, forming small yet well-defined channels. These distinct channels where the soil has been washed away are called rills when they are small enough to not interfere with field machinery operations.
- **Gully Erosion-** Gully erosion is an advanced stage of rill erosion where surface channels are eroded to the point where they become a nuisance factor in normal tillage operations. Surface water runoff, causing gully formation or the enlarging of existing gullies, is usually the result of improper outlet design for local surface and subsurface drainage systems.
- **Bank Erosion-** Natural streams and constructed drainage channels act as outlets for surface water runoff and subsurface drainage systems. Bank erosion is the progressive undercutting, scouring and slumping of these drainage ways.
- **Wind Erosion-** Wind erosion occurs in susceptible areas of mainly sandy and organic or muck soils. Under the right conditions it can cause major losses of soil and property. Soil particles move in three ways, depending on soil particle size and wind strength – suspension, saltation and surface creep.

The rate and magnitude of soil erosion by wind is controlled by the following factors:

1) **Soil Erodibility**- Very fine soil particles are carried high into the air by the wind and transported great distances (suspension).
2) **Deforestation-** Without plant cover, erosion can occur and sweep the land into rivers.

Effects of Soil Erosion

- Loss of topsoil
- Soil compaction
- Reduced organic and fertile matter
- Poor drainage
- Issues with plant reproduction
- Soil acidity levels
- Long term erosion
- Water pollution

Solutions for Soil Erosion

- Careful tilling
- Crop rotation
- Increased structure for plants
- Water control
- Increased knowledge to protect crops

4. Soil conservation

Prevention of soil erosion is also called conservation of soil.

The soil erosion can be prevented by the following ways:

1. **Afforestation -** Planting new trees and plants is afforestation. We live because plants live. If the plants die, all living things will also die. Thus, whenever trees are cut down new trees should be planted. Planting trees in hilly areas are most effective for conservation.
2. **Crop Rotation -** Between harvesting one crop and planting the next crop, the fields lie bare; there is a time period when the farmland does not have any crops. During this period, the farmer either grows grass or grows other crops to prevent soil from erosion. This helps the soil to regain the lost minerals.
3. **Terrace Farming** - In hilly areas, farming is done by cutting steps on the slopes of the hills. This slows down the flow of water and soil removed from one step is deposited on the next step. Thus, the soil is never completely lost. This is terrace farming.
4. **Building Dams** - Dams are built to prevent floods, which not only damage the crops but also wash away the topsoil.
5. **Shelterbelts -** The cover of plants and trees around the field also breaks the speed of strong winds and protects the soil from being blown away.
6. **Embankments** -Big strong structure called embankments along the banks of the river can protect fields from the floods. These embankments prevent the fast-overflowing rivers and rainwater from washing away a huge amount of rich fertile soil.

5. Watershed management

- Watershed is defined as a geohydrological unit draining to a common point by a system of drains. All lands on earth are part of one watershed or other. Watershed is thus the land and water area, which contributes runoff to a common point.
- A watershed is an area of land and water bounded by a drainage divide within which the surface runoff collects and flows out of the watershed through a single outlet into a larger river (or) lake.

TYPES OF WATERSHEDS

Watersheds is classified depending upon the size, drainage, shape and land use pattern.

- **Macro watershed (> 50,000 Ha)**
- **Sub-watershed (10,000 to 50,000 Ha)**
- **Milli-watershed (1000 to10000 Ha)**
- **Micro watershed (100 to 1000 Ha)**
- **Mini watershed (1-100 Ha)**

Some of the watershed management structures are as follows.

1. **Broad beds and furrows**- The broad bed and furrow system is laid within the field boundaries. The land levels are taken and it is laid using either animal drawn or tractor drawn ridgers. Its function is to control erosion and to conserve soil moisture in the soil during rainy days.
2. **Contour Bunds**- It helps to control run off velocity. The embankment may be closed or open, surplus arrangements are provided wherever necessary.
3. **Bench Terracing**- It consists of construction of step like fields along contours by half cutting and half filling. Original slope is converted into level fields. The vertical & horizontal intervals are decided based on level slope. It helps to bring sloping land into different level strips to enable cultivation.
4. **Micro catchments for sloping lands.**

Technique	Storage capacity per unit (m3)	Annual run-off contribution to soil moisture Additional water stored per ha (m3)	Estimated surface Run-off control (%)
Triangular catchments (V-Bunds)	13	5200	80
Crescent bunds	10.2	4080	73

It is useful for in-situ moisture conservation and erosion control for tree crops.

5. **Check Dams**

- A low weir normally constructed across the gullies
- Constructed on small streams and long gullies formed by erosive activity of flood water

6. **Percolation pond**: To augment the ground water recharge
7. **Stone Barriers**

Water Resource

1. Irrigation Management: types of irrigation

Irrigation

- Irrigation is application of water to the soil for crop growth and development.
- Application of water to plants is made naturally through rainfall and artificially through irrigation.
- Irrigation can be defined as the artificial application of water to the soil for the purpose of crop growth or crop production in supplement to rainfall and ground water contribution.

Sources of irrigation

- **Rainfall -** ultimate source of all kind of water.

Based on sources of irrigation water, classified as: -

- **Surface water** - includes precipitation (including rainfall and dew) water available from river, tank, pond, Lake, etc.,
- **Subsurface water** - includes subsurface water contribution, underground water, tube well etc

System of Irrigation

Depending upon the crops, soil types, water resources, climate conditions and costs involved, different systems of irrigation are used which are as follows: -

1. **Surface irrigation systems**
2. **Sub Surface irrigation systems**
3. **Micro- irrigation systems (Drip and Sprinkler irrigation)**

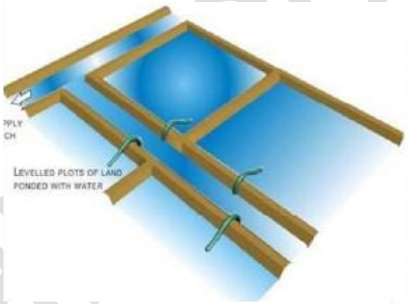
Surface Irrigation System:

- Water is directly applied on the surface of the soil and water follows the slope of the land. Water is applied to the field in either the controlled or uncontrolled manner.
- **Controlled:** Water is applied from the head ditch and guided by furrows, borders, or ridges.
- **Uncontrolled:** Flooding
    - Surface irrigation is entirely practiced where water is abundant.
    - Low initial cost of development is later offset by high labor cost of applying water.
    - Deep percolation, runoff and drainage problems occurred.

Flood irrigation:

- Flood irrigation is used for lowland rice and where farm fields are levelled and water is abundant.
- Water is allowed to advance from different sources and remains on a field for a given period, depending on the crop, the porosity of the soil and its drainage.
- When the land is flat, letting in water from one end floods the entire area.
- It is the easiest method; labor requirement is minimum
- But in this there is wastage of water and leads to soil erosion also.
- It encourages growth of weeds and spread of diseases like gummosis in citrus and collar rot in papaya.

Check Basin irrigation:

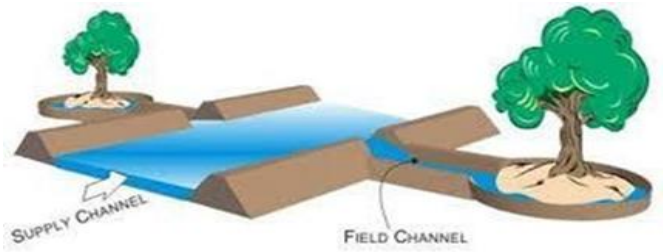


- Suitable for close growing crops like wheat and millets, etc.
- It is the most common surface irrigation method.
- Field is divided in to smaller unit areas surrounded by bunds.
- Uniform application of water but land is wasted under bunds and channels.
- The water applied to a desired depth can be retained until it infiltrates into the soil.
- The size of the basin varies depending upon soil type, topography, stream size and crop.

Furrow irrigation:

- In furrow irrigation, water moves in the fields in furrows, between two ridges.
- It is employed in the fields with row crops such as cotton and vegetables.
- Parallel furrow called corrugations, are used to spread water over fields that are too irregular to flood.
- Water poured on the field is directed to flow through narrow channels dug between the rows of crops, instead of distributing the water throughout the whole field evenly.

Ring basin irrigation:



- This is an improvement over the basin system.
- In this system, a ring is formed close and around the tree and water is let into the basin.
- This method is recommended for citrus trees thereby reducing the chances of collar rot to which these trees are often susceptible.
- Suitable for close growing crops and medium to heavy textured soil but not suitable for sandy soils.

Sub-Surface Irrigation System:

- In this system, irrigation is done into a series of ditches in the field deeply to the impervious layer or through underground perforated pipes.
- Then it moves laterally and vertically through capillaries saturating the root zone.
- Continuous supply of water in the root zone is assured from the artificial water table created by the ponding of irrigation water in the impervious layer.
- This system is very efficient because the water losses through evaporation from surface can be reduced.
- This system is more common in Gujarat and Jammu and Kashmir, for cash crops growing on sandy loam soils.

Micro- irrigation system:

Drip Irrigation System:

- It is also called trickle irrigation.
- Developed by Symcha Blase, an Israeli engineer.
- Slow application of water drop by drop to the root zone of a crop.
- Done through mechanical devices called emitters, located at selected points along water delivery lines.
- Drip irrigation is extensively used in areas of acute water scarcity and especially for crops such as coconut, grape, banana, citrus, sugarcane, cotton, maize, tomato and plantation crops.

Advantages of Drip irrigation:

- Water loss through transpiration is low.
- It is possible to obtain better yield and quality of crops by controlling soil moisture-air nutrient levels.

- We can save the fertilizers by monitoring the supply of nutrients as per the need of the crop.
- Discharge rate is 1 – 4 litres/hr.
- WUE is 90 – 95%.
- Fertigation (fertilizer + irrigation) and Herbigation (herbicide + irrigation) can also be done along.
- Occurrence of disease and weed infestation is less.

Disadvantages of Drip irrigation:

- Initial cost is high.
- Clogging of emitters.
- Only suitable for wider spaced crops.
- Root growth is restricted.
- Requires high level of design, maintenance and management.

Sprinkler Irrigation System:

- Irrigation is done in the form of a thin spray or as rain drops through pressure to the surface of any crop or soil.

- Uses less water and provides better control.
- Each sprinkler, spaced along a pipe, sprays water in a continuous circle until the moisture reaches the root level of the crop.
- To achieve uniformity while sprinkling, it is necessary to overlap the area of influence of each sprinkler.
- This system requires high energy and involves huge cost of the equipment.
- Rate of discharge is > 1000 litres/hr.
- Pressure > 2.5 bar.
- WUE is 50 – 60%.
- Suitable for undulating lands and steep slopes
- Suitable for saline soils to leach down salts. During high wind velocity it is not suitable.

Terminology related to irrigation

- **Percolation:** - Vertical movement of water in the soil, occurs in saturated soil.
- **Infiltration:** - Entry of water or downward movement of water from upper layer of soil, occurs in unsaturated soil.
- **Seepage:** - Horizontal flow of water in irrigation channels.
- **Leaching**: - Downward movement of nutrients and salts with water from the root zone.

- **Runoff**: - Flow of excess water from the field after saturation of soil.
- **Base period:** - The period (days) of irrigation from that crop requires for full maturity.
- **Duty of water:** - Quantity of water required for irrigation to bring a crop to maturity. Duty of water = 8.64 x Base period
- **Delta**- Total depth of water required by a crop during entire crop period in the field.

Major, Medium and Minor irrigation Projects

Classification of irrigation projects

- The irrigation projects can be classified as Major, Medium and Minor on the basis of cultural command area and financial expenditure.
- CCA - It is the area which can be physically irrigated from a scheme and is fit for cultivation.

Irrigation Projects	Culturable Command Area (CCA)	Financial Expenditure (Rs)
Major	>10000 ha	>5 crores
Medium	2000 – 10000 ha	25 lakh -5 crores
Minor	<2000 ha	< 25 lakhs

Farm and Agri Engineering

1. Farm Machinery and Power

AGRICULTURAL IMPLEMENTS: Devices attached to, pulled behind, pushed, or otherwise used with human, animal or mechanical power source to carry out an agricultural operation.

AGRICULTURAL MACHINERY: General term used to describe tractors, combines, implements, machines and any other device more sophisticated than hand tools which are animal or mechanically powered.

AGRICULTURAL EQUIPMENTS: Referring to stationary mechanical devices such as irrigation pump-set.

Tillage implements	Examples
Primary Tillage implements	Plough- Turn and Break soil (Mouldboard plough, Disc plough, Chisel plough, Rotary Tiller, Subsoiler, Wooden plough)
Secondary Tillage implements	Harrows- Pulverizing and Preparation of seed bed (Disc Harrow, Spike tooth Harrow, Spring tooth Harrow, Acme Harrow, Patela Harrow Cultivators- Breaking clods and destroy weeds (Tractor drawn and sweep) Planks

Primary Tillage Implements:

Mouldboard Plough

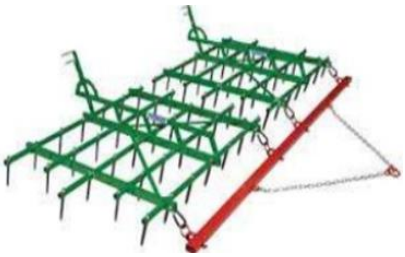
Disc Plough

Rotary Tiller (Rotavator)

Chisel Plough **Subsoil Plough** **Wooden Plough**

Secondary Tillage Implements

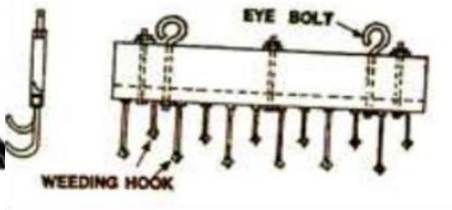
Disc Harrow



Spike tooth Harrow

Spring tooth Harrow

Acme Harrow



Patela Harrow

Triangular Harrow

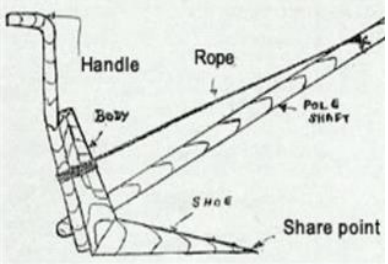
Blade Harrow

Sweep Cultivator

Tractor Drawn Cultivator

Rollers

Implements for Layout of Seedbed	Country Plough and Ridge Plough (Earthing up and forming ridge and furrows) Bund Former
Implements for sowing	Plough, Seed drill (Ferti-cum-Seed Drill and Mechanical Seed Drill)
Implements for inter-cultivation	Wooden plough, small blade harrow, Weeders – Rotary weeders



Country Plough

Seed Drill

Rotary Weeders

2.Sources of power on the farm- human, animal, mechanical, electrical, wind, solar and biomass, bio fuels

Agricultural operations classified as:

- **Tractive work** (seed bed preparation, cultivation, harvesting and transportation)
- **Stationary work** (silage cutting, feed grinding, threshing, winnowing and lifting of irrigation water)

The different forms of energy used for agriculture (farm power) in India are: **Human energy (human power), Animal energy (animal power), Mechanical energy (mechanical power) such as Tractors, Power tillers, Self-propelled combines, Oil engines), Electrical energy (electrical power) and Renewable energy (Biomass, Solar energy and Wind energy).**

Human Power

- For operating small farm implements and tools.
- Stationary work such as chaff cutting, feed grinding, water lifting, threshing, winnowing etc. and field work such as weeding, broadcasting.
- Maximum power of an av. man labor is 0.1 hp and av. women labor is 0.05 hp for doing farm work.

Animal Power

- Bullocks, buffaloes, camels, horses, donkeys (can pull 80 % of its weight for short period and 10-15% of its weight for sustainable period.), mules and elephants as a source of animal power.
- Average force of a draft animal: 1/10th of its body weight.
- Maximum power of a pair of bullocks is about 1 hp.

Mechanical power (stationary oil engines, tractors and power tillers)

- Internal combustion engine changes Chemical Energy into Mechanical Energy

Two types of IC engines :

- Compression ignition engines (Diesel engine, efficiency 32-38 %)
- Spark ignition engine (Petrol / Kerosene engine, efficiency 25-32 %)
- Diesel engine are main source of power in agriculture. These are present in tractors and most of the power tillers. Also used to perform stationary operations like water lifting, flour mills, chaff cutters, processing equipment's, threshers, winnowers etc.

Electrical power:

- For operating electrical motors in pump sets, high-tech nursery, diary industry, cold storage, farm product processing, fruit industry and food processing industries.

- Maintenance and motor operations need less attention or care. Operating cost remains constant.
- Clean and efficient source of energy

Renewable energy (Wind, Solar and Biomass energy)

Wind energy: Electricity generation, water pumping

- As of 28 February 2021, the total installed wind power capacity in India was 38.789 GW, the fourth largest installed wind power capacity in the world.
- The Muppandal Wind Farm is India's largest operational onshore wind farm. This project located in Kanyakumari district, Tamil Nadu. The project was developed by Tamil Nadu Energy Development Agency. Its installed capacity is 1,500 MW, which makes it the 3rd-largest operational onshore wind farm in the world.

Solar energy: Solar lighting, solar refrigeration, solar dryers, cooker, lantern, solar still, photovoltaic system for water pumping

- Solar power in India is a fast-developing industry as part of the renewable energy in India. The country's solar installed capacity was 40.09 GW as of 31 March 2021.
- Bhadla Solar Park is the largest solar park in the world as of 2020 with a total capacity of 2245 MW, and is spread over a total area of 5,700 hectares (14,000 acres) in Bhadla, Phalodi tehsil, Jodhpur district, Rajasthan, India.

Biomass energy : Pyrolysis, gasifiers, biogas

- Biomass energy
- Biomass contains energy stored from the sun. Plants absorb solar energy through photosynthesis. When burnt, it releases chemical energy in the form of heat.

Biofuels (a part of biomass energy)

- Biofuels can be produced from organic matter, or biomass, such as corn or sugar, vegetable oils or waste feedstocks. Examples of biofuels include
- Ethanol (often made from corn in the United States and sugarcane in Brazil)- by fermentation. It is used in blended fuels with petrol, either at low levels in regular vehicles (up to 10%) or at higher levels in cars that have been adapted to take both ethanol and petrol, also called “flex-fuel” vehicles.
- Biodiesel (from vegetable oils and liquid animal fats)- It is blended with diesel, generally at low levels (up to 7%) and is obtained from oil bearing seeds producing trees such as Jatropha, Pungam etc

Green diesel (derived from algae and other plant sources)

- Biogas (methane derived from animal manure and other digested organic material by the action of acetogenic and methanogenic bacteria). In addition to biogas, nutrient rich

"digested effluent" is also obtained. The predominant types of bioreactors for generating biogas high rate reactors such as Upflow anaerobic slugde blanket, hybrid reactors and various biogas plants like floating drum, Janatha, Deenbandhu

Advantages: (of Renewable energy over other sources)

- Non depleting in nature
- Inexhaustible and can be reproduced (replenishable mostly).
- Power plants running on renewable energy have no fuel cost thus, negligible operating cost
- More site-specific (used for local processing)
- No need for distribution and transmission of power
- Nature friendly (non- harmful in nature)

Disadvantages

- Higher upfront cost (than traditional energy generators)
- Intermittency (not available 24/7, year-round)
- Geographic limitations

3.Water harvesting structures, farm ponds

Farm Ponds

Farm Pond is a dug-out structure with definite shape and size and also with proper inlet and outlet structures for collecting the surface runoff flowing from the farm area. It is one of the most important rain water harvesting structures constructed at the lowest portion of the farm area. The stored water must be used for irrigation only.

Farm ponds can be designed for three strategies of irrigation in rainfed regions as below:

- To meet the crop water requirements of growing season
- To meet the water requirement of critical irrigation (CRI) during the crucial stages of crop growth
- To meet the water requirement in cropping system approach (Irrigation during the crucial stages of kharif crop plus the water requirement of rabi vegetables).

Depending on the source of water and their location, farm ponds are grouped into four types:

- **Excavated or dug out ponds**

Dugout Ponds are excavated at the site and the soil obtained by excavation is formed as embankment around the pond. The pond could either be fed by surface runoff or groundwater wherever aquifers are available. In case of dugout ponds, if the stored water is to be used for irrigation, the water has to be pumped out.

- **Surface ponds**

Surface water ponds are the most common type of farm ponds. These are partly excavated and an embankment is constructed to retain the water. Generally, a site which has a depression already is chosen for this pond construction

- **Spring or creek fed ponds**

Spring or creek fed ponds are those where a spring or a creek is the source of water supply to the pond. Construction of these ponds, therefore, depends upon the availability of natural springs or creeks.

- **Off stream storage ponds.**

Off-stream storage ponds are constructed by the side of streams which flow only seasonally. The idea is to store the water obtained from the seasonal flow in the streams. Suitable arrangements need to be made for conveying the water from the stream to the storage ponds

Farm ponds are small water bodies formed either by the construction of a small dam or embankment across a waterway or by excavating or dug out. The water is usually harvested from a small catchment area and then used for irrigation during prolonged periods.

Specifications:

In the selected farm land the farm pond dimension of 8m x 8m x 1.5m can be constructed for the every 1 or 2 ha of land area.

Water spreading area (sq.m)	Depth of water (m)	Suitable uses
2000 to 10000	2.5 - 3.0	Irrigation, fisheries and drinking water
2000 to < 10000	1.5 – 2.5	Irrigation & drinking water
< 2000	1.5-2.5	Pot irrigation for trees and drinking water

Design of Farm Pond

The design of farm ponds consists of

- Selection of site
- Determination of the capacity of the pond
- Design of the embankment
- Design of the mechanical spillway
- Design of the emergency spillway
- Providing for seepage control from the bottom

4.Agro Processing, Controlled and modified storage, perishable food storage, godowns, bins and grain silos.

Agricultural Processing

In Agriculture, product refers to processed agricultural produce which has been turn into finish goods either for human/animal consumption or for industrial uses.

Processing

- Processing in agriculture involves the biological, physical, mechanical, and biochemical manipulation of agricultural produce in other to preserve it for further use. It involves the series of operations taken to change agricultural products into a consumer-finish product. Agricultural processing involves both scientific and traditional manipulation of agricultural produce so as to make it to be more useful and be able to store them for future uses.

Requirement of processing: -

- Processing helps to make food available even during the off-season.
- When food is processed it taste and look very attractive
- helps in the durability of food crop products- when food crop is been processed like in dehydration of a food crop, micro-organisms becomes absent thereby preventing spoilage.
- Adds value to the agricultural produce.
- Helps in producing income to individual and foreign exchange

Storage

Storage is an important marketing function involving holding and preserving foods from the time they are produced until they are needed for consumption.

- The storage of foods, therefore, from the time of production to the time of consumption, ensures a continuous flow of foods in the market.
- Storage protects the quality of perishable and semi-perishable products from deterioration.
- Some of the farm products, have a seasonal demand. To cope with this demand, production on a continuous basis and storage become necessary.
- It helps in the stabilization of prices by adjusting demand and supply.
- Storage is necessary for some period for performance of other marketing functions.
- Storage provides employment and income through price advantages.
- Ensure availability of seeds for the crop cycles to come
- Guarantee regular and continuous supplies of raw materials for processing industries;
- Balance the supply and demand of agricultural products, thereby stabilizing market prices.

Classification of Storage

- Duration of storage (Short term, Medium term and Long term)
- Size or scale of storage (small, medium and large)
- Principle of storage (Physical, chemical and biological)

Agents causing deterioration of stored grain

- Micro-organisms
- Insects
- Rodents

Controlled and Modified atmosphere storage

Controlled Storage

A controlled atmosphere is an agricultural storage method in which the concentrations of oxygen, carbon dioxide and nitrogen, as well as the temperature and humidity of a storage room are regulated. Both dry commodities and fresh fruit and vegetables can be stored in controlled atmospheres. Controlled or modified atmosphere storage should be used as a supplement to, and not as a substitute for, proper temperature and relative humidity management.

Some simple methods for modifying the composition of air in the storage environment are –

1. Control of Oxygen gas :

2. Carbon dioxide control :

3. Ethylene control :

Modified Storage

Modified atmosphere is the practice of modifying the composition of the internal atmosphere of a package (commonly food packages, drugs, etc.) in order to improve the shelf life.

Storage of perishable products

Perishable food includes fruits and vegetables, fresh meat, foods purchased from chill cabinets, freshly cooked food stored to be used later. It is usually stored in a refrigerator. Some fresh fruits and vegetables, however, will store quite well out of the refrigerator as long as they are stored in a cool place.

- Refrigeration
- Cartons
- Cold Storage
- Warehouse
- Three public sector agencies are involved in building large-scale storage and warehousing capacities in the country. These are as follows
    a. Food Corporation of India (FCI)
    b. Central Warehousing Corporation (CWC)
    c. State Warehousing Corporations (SWCs)

Uses of Warehouses:

- Scientific storage of produce from the vagaries of weather, rodents, insects and pests. They prevent quality and quantity losses.
- Meeting the financial needs of people who store the produce by providing value for the goods stored.
- Regulating price levels by regulating the supply of goods in the markets. More goods from the buffer are released when supplies are less and less is released when supplies are more in the markets
- Offering market intelligence in the form of price, supply and demand information so that market users may develop selling and buying strategies.

Grain is generally stored either in bags or in bulk. A combined system of bag-cum-bulk storage is also practiced in some parts of the country. In villages the bulk storage system is more common than the storage in bags which is considered to be a practicable method· of storing grain in the government godowns as well as in trade.

There are mainly following three types of storage structures for storage of grains.

- Traditional storage structures
- Improved storage structures
- Modern storage structures (Farm Silos)

I. Traditional Storage Structures

1. Morai type storage structures
2. Bukhari type storage structures

3. Kothar type storage structure
4. Mud Kothi type storage structure
5. Muda type storage structure
6. Kanaj type storage structure
7. Kuthla type storage structure
8. Metal/ Steel bin type storage structure

II. Improved Storage Structures

1. Pusa bin
2. PAU bin
3. Hapur tekka
4. For large scale storage
5. Brick and cement bin
6. Bunker Storage
7. 'CAP' Storage structures

III. Modern Storage Structures

- Silo type of storage structures
- Silos/bins are classified into two groups depending upon the relative dimensions of the container. These are classified as

(a) shallow bins (b) deep bins.

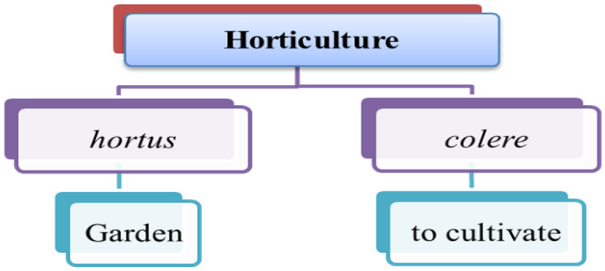
Vertical silos

a) Flat bottom vertical silo

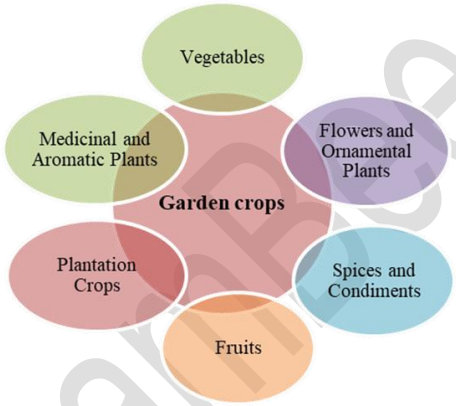
b) Hopper bottom vertical silo

Plantation & Horticulture:

1. Definition, meaning and its branches.



Horticulture is the part of agriculture which is concerned with cultivation of garden crops

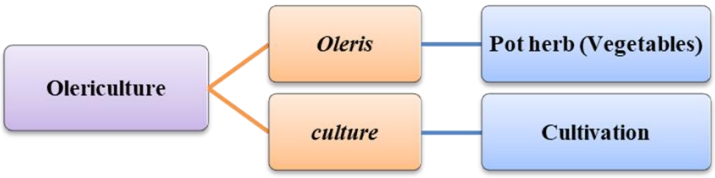


Branch of Agriculture concerned with intensively cultured plants directly used by people for food, medicinal purpose or for aesthetic gratification

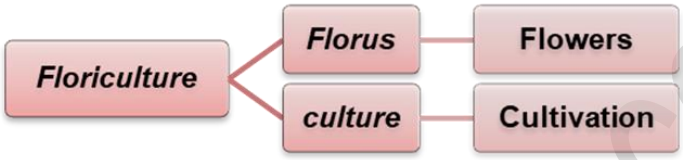
Branches of Horticulture

- **Pomology-** The branch of horticulture, concerned with the production, harvesting, processing, preservation, storage and marketing of fruits and nuts.

- **Olericulture-** The science and practice of growing, handling, storing, processing and marketing of vegetables.



- **Floriculture-** The science and practice of growing, handling, storing, processing and marketing of flowers.



4. **Plantation Crops**- Cultivation of crops like coconut, arecanut, rubber, coffee etc.

Tea

Coffee

- **Spices Crops**- Cultivation of crops like, cardamom, pepper, nutmeg etc.
- **Medicinal and Aromatic Crops**- Cultivation of medicinal and aromatic crops.
- **Post-harvest Technology**- Methods and techniques applied to increase the shelf – life and to retain the quality of fresh or processed horticultural produce.

Plant Propagation-

- Plant propagation: refers to the multiplication of one plant into several plants development of new individuals.
- Plant propagation is the process of creating new plants from a variety of sources: seeds, cuttings, bulbs and other plant parts.
- Plant propagation can also refer to the artificial or natural dispersal of plants.

Methods of propagation

1. Sexual
2. Asexual.

Sexual propagation

- Multiplication of plants by seeds
- Plants produced may or may not be similar to their parents

Advantages of Seed propagation

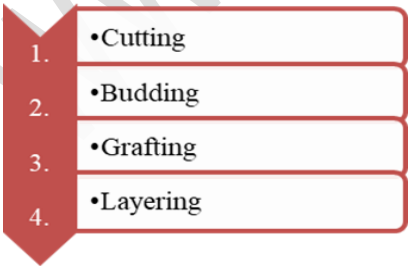
- Seedling trees generally live longer, bear more heavily and are hardier than vegetatively propagated trees.
- Seedlings are comparatively cheap, and can be more easily raised than vegetatively propagated materials.
- Plants which are difficult to propagate, e.g., papaya by vegetative method can only be propagated by seed.
- Seed propagation, some times results in the production of Chance seedlings.
- Rootstocks, on which desirable scion variety is budded or grafted, are usually raised from seeds.
- Since most virus diseases are usually not transmitted through seed propagation. Hence, it is useful in producing virus free plants.

Disadvantage

- Not true to types
- Seedling trees take more time to come to bearing than grafted plants
- Ex. mango seedlings take 8 -10 years to come to bearing, compared with 3-4 years for grafted trees.
- Seedling trees are not uniform in their growth, yielding capacity and fruit quality

Asexual propagation (Vegetative propagation, Clonal propagation)

- Reproduction by means of vegetative parts of the plant such as roots, shoots, or leaves other than seed.



Advantages

- No change in the genetic makeup

- Some fruits such as banana, pineapple and some guava varieties being seedless, the only way of further propagation is vegetative method.
- Vegetatively propagated fruit trees come into bearing earlier

Disadvantage

- Vegetative propagation in many cases is more expensive than seed propagation.
- Vegetatively propagated plants are comparatively short lived, there is lack of tap root system.
- Vegetatively propagated plants are comparatively less hardy.

Propagation methods commercially used in Fruit crops

Fruit Crops	Propagation methods
Mango	Veneer Grafting
Banana	Sword suckers
Papaya	Seed
Guava	Stooling/Mound layering
Litchi	Air Layering
Sapota	Inarching
Strawberry	Runners
Jackfruits	Inarching
Apple, Pear, Apricot	Tongue Grafting
Peach, Plum, Olive	T- Budding
Grapes, Fig	Hardwood Cutting
Pomegranate	Hardwood Cutting and Air Layering

Difference between Fruits and Vegetables

Fruits	Vegetables
Edible part generally formed from (flower part) or inflorescence	It can be leaf, root, stem, flower etc
Generally consumed raw not during principal meal	Generally consumed as cooked during principal meal
Acidic in nature	Non acidic in nature
Perennial in nature	Annual and biennial in nature
Mostly woody in nature	Non woody in nature
Mostly propagated asexually	Mostly propagated by seeds

PLANTATION CROPS

- **Definition:** A group of commercial crops of perennial nature, cultivated extensively in tropical and subtropical situations which need employment of labour through out the year and the produces of which are usually consumed after processing.
- **Definition in traditional sense** – Plantation crops are those which are cultivated on extensive scale like tea, coffee and rubber. Here the term plantation or estate is used synonymously.
- Estate or plantation means large scale agricultural unit usually of a single crop.

Differences between plantation crops vs. fruit crops:

Features	Plantation Crops	Fruit crops
1. Climate under which cultivated	Tropical mainly between 20 º N and 20 º S Latitude	Tropics, Subtropics and temperate
2. Necessity of training and pruning	Less	More
3. Suitability for Consumption	Processed and consumed	Major portion is consumed directly in fresh form
4.Perishabilityof produce	Less/ not perishable	Perishable
5. Export potential/ Foreign Exchange earnings	Comparatively high	Some portion of fruits and preserved products are exported.
6. Uses	Diversified: i.e., in medicines, beverages and oilseeds etc	Used mostly as protective foods (Rich in vitamins and minerals)

Important Research Stations on Plantation and Beverage Crops

1. Coconut : Central Plantation Crop Reserch Institute , Kasargode, Kerala
2. Arecanut : CPCRI, Regional Research Station, Vittal, Karnataka
3. Cocoa - CPCRI, Regional Research Station, Vittal, Karnataka
4. Rubber: Rubber Research Institute of India, Kottayam, Kerala
5. Cashew : Directorate of Cashew Research, Puttur, Karnataka
6. Oil Palm : National Research Centre, Elur, Pedavegi, Andhra Pradesh
7. Palmyrah : Srivaliputtur, Tamil Nadu
8. Tea : Tea Research Institute, United Planters Association of South India (UPASI), Valparai, Tamil Nadu
9. Coffee : Central Coffee Research Institute, Balehonnur, Karnataka

2.Post-harvest management, value and supply chain management of Plantation and Horticulture crops.

Post-harvest Management

- Methods and techniques applied to increase the shelf – life and retain quality of fresh or processed horticultural produce.
- **Why post-harvest management important?**
    - Food Safety
    - Quality assurance
    - Better storage
    - Better protection from pests
    - Reduce losses (quantity & quality)
    - Better marketing opportunities

Maturity and maturity indices in fruits and Vegetables

- **Horticultural maturity**: It is a developmental stage of the fruit on the tree, which will result in a satisfactory product after harvest.

- **Physiological maturity:** It refers to the stage in the development of the fruits and vegetables when maximum growth and maturation has occurred. It is usually associated with full ripening in the fruits. The Physiological mature stage is followed by senescence.

- **Commercial maturity**: It is the state of plant organ required by a market. It commonly bears little relation to Physiological maturity and may occur at any stage during development stage.
- **Harvest Maturity**: It may be defined in terms of Physiological maturity and horticultural maturity, it is a stage, which will allow fruits / vegetables at its peak condition when it reaches to the consumers and develop acceptable flavour or appearance and having adequate shelf life.

Methods for measurement of Maturity indices

Physical methods

- Size, weight, shape, surface morphology, specific gravity etc.

Computational methods

- Calendar date
- T- stage
- Days from full bloom to harvest

Physiological methods

- Respiration rate, ethylene evolution, internal ethylene concentration.

Chemical methods

- Determination of acidity, TSS/acid ratio, sugar, starch content etc.

Criteria of maturity for harvesting fruits and vegetables Fruit	Physical	Chemical
Mango	Olive green colour with clear lenticels, shoulder development size sp. gravity, days from fruit set.	Starch content, flesh colour
Banana	Skin colour, drying of leaves of the plant, brittleness of floral ends, angularity of the fruit, and days from emergence of inflorescence.	Pulp/peel ratio, starch content
Citrus	Colour break of the skin from green to orange, size	Sugar/acid ratio, TSS
Grapes	Peel colour, easy separation of berries, characteristic aroma	TSS 18-12 Thompson seedless, 12-14 for Bangalore Blue, 14-16 for Anab-e-shahi
Apple	Colour size	Firmness as measured by pressure tester
Papaya	Yellow patch or streaks.	Jelliness of the seed, seed colour

- **Pre cooling**
- **Removing of field heat.**
- **Minimizes susceptibility to attack of micro-organisms.**
- **Slows down the respiration of the produce.**

Types of pre-cooling

- **Room cooling-** Produce is packed in containers which are loosely stacked in the cooling room, leaving enough space between containers for each one to be exposed to circulating cold air.
- **Air cooling**- Cold air is forced to flow through the inside of each container
- **Hydro cooling**- Produce is exposed to cold water by means of showering or dipping
- **Vacuum Cooling**- Pressure is reduced to about 660 pascals in vacuum chamber.

Advantage- Faster and uniform cooling.

- Package-icing or top icing- Adding crushed ice, flake ice or slurry of ice in containers. For liquid icing, slurry of ice and water (60% ice and 40% water). It gives a much greater initial contact between the produce and the ice.

Curing

- Curing is an effective operation to reduce the water loss during storage from hardy vegetables viz, onion, garlic, sweet potato and other tropical root vegetables. The curing methods employed for root crops are entirely different than that from the bulbous crops (onions and garlic). Strengthens the skin of vegetables
- Induced at a relatively higher temperature and humidity.
- Suberization of outer tissues followed by the development of wound periderm which acts as an effective barrier against infection and water loss.

Waxing

- Waxing generally reduces the respiration and transpiration rates, but other chemicals such as fungicides, growth regulators, preservative can also be incorporated specially for reducing microbial spoilage, sprout inhibition etc.

Disadvantage

- Development of off- flavor if not applied properly.
- Fungicide, growth substances (other chemical also) + edible wax

Wax type

- **Storage wax** – applied to fruits which are used for storage
- **Pack out wax** – where immediate marketing of fruits are practiced
- **High shine wax** – used to improved market demand.

Packaging

- **Function**
  - To assemble the produce in convenient units for handling.
  - To protect the produce during transportation and marketing operation.
- **Common packages**
  - Wooden boxes
  - Wire bound boxes
  - Bamboo baskets
  - Corrugated fibreboxes
  - Plastic crates
  - Jute bag
- **Storage**
  - Improve commodity quality
  - Usefulness
  - Control market glut
  - Slow the biological activity without chilling injury
  - Slow the growth of micro-organisms
  - Reduce transpiration loss

Preservation

- Method by which food is kept out from spoilage after harvest.
- Nicholas apart is recognized as father of food preservation.
- Food Product Order was passed in 1955 by Govt. Of India to control quality of food.

Methods of Preservation

- **Asepsis:** Prevention of microbes by maintaining general cleanliness during various operations.
- **Pasteurization:** heat treatment of food materials followed by rapid cooling to deactivate/suppress microorganisms.
- **Sterilization:** Complete exclusion of microbes using high temperature, for fruits and vegetables 100°C for 30 minutes and for non-acidic vegetables are sterilized at 116°C temperature for 30 minutes.
- **Refrigeration:** The shelf life of some food materials (like fresh foods and vegetables, eggs, dairy products, and meat) can be increased by storage at 4°C or below.
- **Freezing:** is done at -18°C to -4°C.
- **Chemicals:** according to FPO, Sulphur di oxide and Benzoic acid can be used as preservatives in India.
- **Sulphur dioxide** is used in the form of KMS (Potassium meta bisulphite), KMS retains the original color of beverages, that's why used for colored beverages. For RTS and Nectar permissible amount is 100 ppm and for Squash, Crush and Cordial it is 350 ppm.
- **Benzoic acid** is used as Sodium Benzoate and permitted upto 100 ppm in nectar and RTS , 600 ppm for Squash, Crush and Cordial.

- **Preservation by chemical preservatives–**

  - **Class I preservatives–Sugar, Salt, Spices**
  - **Class II preservatives–Sodium Benzoate, Potassium meta bi sulphate**

  - Salt act as a preservative at concentration of 15 –25%.
  - Sugar act as a preservative at 62 –65%
  - Alcohol acts as a preservative in wines at 14%
  - Acetic acid (vinegar), Citric acid and lactic acid are commonly used for preservation
  - Vinegar contains 5% acetic acid
  - About 2% acetic acid prevents spoilage in many products
  - pH level of majority of fruit juices is 3.5 –4.0
  - Recommended level of sodium benzoate in fruit juices : 0.06 to 0.1%
  - Sodium benzoate is used in coloured fruit product (e.g. Tomato products).
  - KMS (Potassium Meta bi Sulphite) is used against colourless fruit juices/ pulp.

Post Harvest Research Centres in India

- Central Food Technology Research Institute (CFTRI), Mysore, Karnataka
- Central Institute of Post Harvest Engineering and Technology (CIPHET), Ludhiana, Punjab
- Fruit Preservation and Canning Institute (FPCI), Lucknow, Uttar Pradesh
- Central Food Laboratory (CFL), Kolkata, West Bengal

Animal Husbandry:

1. Common terms pertaining to different species of livestock

S. No.	Details	Cattle	Buffalo	Sheep	Goat	Pig	Poultry	Horse
1	Group	Herd	Herd	Flock	Flock/Trip	Drove/Herd	Flock	Pack
2	Adult Male	Bull	Buffalo Bull	Ram	Buck	Boar	Cock	Stallion
3	Adult Female	Cow	Buffalo cow	Ewe or Dam	Doe	Sow	Hen	Mare
4	Young Male	Bull calf	Buffalo bull Calf/Buffalo Calf	Ram lamb/ Tup lamb/Male Lamb	Buckling/ Male Kid	Boarling	Cockrel	Colt
5	Young Female	Heifer calf	Heifer calf/Buffalo Heifer calf	Female Lamb/Ewe Lamb/ Gimmer Lamb	Female kid/Goalting	Gilt/ cows or sows	Pullet	Filly
6	New-born	Calf	Buffalo calf	Lamb	Kid	Piglet/Pigling	Chick	Foal
7	Meat	Beef/Calf veal	Buffin	Mutton	Chevon	Pork	Chicken	Chevaline
8	Castrated Male	Bullock/ Steer	Buffalo bullock	Wether/Wedder	Wether/Wedder	Hog/Stag / Barrow	Capon	Gelding/ Geld
9	Mating	Serving	Serving	Tupping	Serving	Coupling	Serving	Covering
10	Parturition	Calving	Calving	Lambing	Kidding	Farrowing	Hatching	Foaling
11	Sound Production	Bellowing	Bellowing	Bleating	Bleat	-	-	whinny, nicker, snort and squeal
12	Female with its offspring	Calf at foot	Calf at foot	Suckling	Suckling	Suckling	Suckling	Foal at foot

2. Utility classification of breeds of cattle

- A breed is a specific group of domestic animals having homogeneous appearance, homogeneous behavior, and/or other characteristics that distinguish it from other organisms of the same species.
- **On the basis of utility indigenous breeds are classified in to three groups**
  - **Milch Breeds / Milk Breeds**
  - **Dual Purpose Breeds**
  - **Draught Breeds**

Milch breeds / milk breeds:

- The cows of these breeds are high milk yields and the male animals are slow or poor work animals.
- Examples - Shahiwal, Red Sindhi, Gir and Deoni
- The milk production of milk breeds is on the average more than 1600 kg per lactation

Dual purpose breeds:

- The cows in these breeds are average milk yielder and male animals are very useful for work.
- Milk production per lactation is 500 kg to 1500 kg.
- Example- ongole, hariana, kankrej, tharparker, krishna valley, rathi and goalo mewathi.

Draught Breeds:

- The male animals are good for work and cows are poor milk yielder
- Milk yield as an average is less than 500 kg per lactation.
- Usually white in color.
- Example- Kangayam, Umblacherry, Amritmahal, Hallikar.

Milch Breeds

Shahiwal

- Best indigenous dairy breed.
- Reddish dun or pale red in colour, sometimes flashed with white patches.
- Heavy breed with symmetrical body having loose skin.
- The average milk yield of this breed is between 1400 and 2500 kgs per lactation.

Red Sindhi

- This breed is also called as Red Karachi and Sindhi and Mahi.
- Originated in Karachi and Hyderabad (Pakistan) regions of undivided India and also reared in certain organized farms in our country.
- Color is red with shades varying from dark red to light, strips of white.
- Milk yield ranges from 1250 to 1800 kgs per lactation.

Gir

- This breed is also called as Bhadawari, Desan, Gujarati, Kathiawari, Sorthi, and Surati.

- Originated in Gir forests of South Kathiawar in Gujarat also found in Maharashtra and adjacent Rajasthan.
- Basic colours of skin are white with dark red or chocolate-brown patches or sometimes black or purely red.
- Horns are peculiarly curved, giving a 'half-moon' appearance.
- Milk yield ranges from 1200-1800 kgs per lactation.

Dual Purpose Breeds

Ongole

- Also known as Nellore, Home tract is Ongole taluk in Guntur district of Andhra Pradesh.
- Large muscular breed with a well-developed hump.
- Suitable for heavy draught work, White or light grey in color.
- Average milk yield is 1000 kgs per lactation.

Hariana

- It was originated from Rohtak, Hisar, Jind and Gurgaon districts of Haryana and also popular in Punjab, UP and parts of MP.
- Horns are small. The bullocks are powerful work animals.
- Hariana cows are fair milkers yielding 600 to 800 kg of milk per lactation.

Kankrej

- It is also called as Wadad or Waged, Wadhiar.
- Originated from Southeast Rann of Kutch of Gujarat and adjoining Rajasthan (Barmer and Jodhpur district).
- The horns are lyre-shaped.
- Colour of the animal varies from silver-grey to iron-grey or steel black.
- The gait of Kankrej is peculiar called as 1 ¼ paces (sawai chal).
- Kankrej is valued for fast, powerful, draught cattle. Useful in ploughing and carting.
- The cows are good milkers, yielding about 1400 kgs per lactation.

Tharparker

- Originated in Tharparkar district (Pakistan) of undivided India and also found in Rajasthan.
- Otherwise known as White Sindhi, Gray Sindhi and Thari.
- They are medium sized, compact and have lyre-shaped horn.
- Body colour is white or light grey.
- The bullocks are quite suitable for ploughing and casting and the cows yield 1800 to 2600 kgs of milk per lactation.

Krishna Valley

- Originated from black cotton soil of the water shed of the river Krishna in Karnataka and also found in border districts of Maharastra.
- Animals are large, having a massive frame with deep, loosely built short body.
- Tail almost reaches the ground.
- Generally grey white in colour with a darker shade on fore quarters and hind quarters in male. Adults females are more whitish in appearance.
- The average yield is about 900 kgs per lactation.

Rathi

- Rathi is an important milch breed of cattle found in the arid regions of Rajasthan.
- Rathi animals are particularly concentrated in Loonkaransar tehsil of Bikaner district, which is also known as Rathi tract.
- The cows on an average produce 1560 kilo grams of milk.
- The lactation milk yield ranges from 1062 to 2810 Kg.
- Selected cows have produced around 4800 Kg at farmer's doorstep.

Draught Breeds:

Kangayam

- Also known as kongu and konganad.
- Originated in Kangayam, Dharapuram, Perundurai, Erode, Bhavani and part of Gobichettipalayam taluk of Erode and Coimbatore district.
- Bulls are grey with dark colour in hump, fore and hind quarters.
- Moderate size with compact bodies.

Umblacherry

- It is also called as Jathi madu, Mottai madu, Molai madu, Therkathi madu.
- Originated in Thanjavur, Thiruvarur and Nagappattinam districts of Tamil Nadu.
- Suitable for wet ploughing and known for their strength and sturdiness.
- Umblachery calves are generally red or brown at birth with all the characteristic white marking on the face, on limbs and tail.

Amritmahal

- Originated in Hassan, Chikmagalur and Chitradurga district of Karnataka.
- Amiritmahals are grey cattle but their shade varies from almost white to near black.
- The muzzle, feat and tail are usually black.

- Horns are long and end in sharp black points

Hallikar

- Originated from the former princely state of Vijayanagarm, presently part of Karnataka.
- The colour is grey or dark grey.
- Compact, muscular and medium size animal with prominent forehead, long horns and strong legs.
- The breed is best known for its draught capacity and especially for its trotting ability.

Khillari

- Originated from Sholapur and Sitapur districts of Maharashtra.
- Closely resembles Hallikar breed.
- Grey-white in colour.
- Long horns turn forwards in a peculiar fashion. The horns are generally black, sometimes pinkish.
- Bullocks are fast and powerful.

Bargur

- Found around Bargur hills in Bhavani taluk of Erode district in Tamilnadu.
- Developed for work in uneven hilly terrains.
- Generally brown colour with white markings.
- Animals are well built, compact and medium in size.
- Known for their speed and endurance in trotting.
- Cautious in behaviour and tends to remain away from strangers.

Alambadi

- Originated from Alambadi of Dharmapuri district in Tamilnadu.
- Grey or dark grey in colour.
- White markings will be seen in forehead, limb and tail.
- Horns are backward curving like Mysore cattle.
- Resembles Hallikar and also known as Betas.
- It is useful in ploughing

3.Introduction to common feeds and fodders their classification and utility.

- The various feeds and fodders used in livestock feeding are broadly classified as:

A) Roughages; B) Concentrates; C) Feed supplements and D) Feed additives.

Roughages – Roughages are the feed stuffs which contain more than 18 percent crude fiber and less than 60 percent Total Digestible Nutrients. Due to higher crude fiber content, they are more bulky and have low digestibility as compared to concentrates.

- **Maintenance type** – Containing 3-5 percent DCP e.g. Green maize, oat.
- **Non-maintenance type** – containing less than 3 percent DCP e.g. Straw, kadbi.
- **Production type** – containing more than 5 percent DCP e.g. Berseem, lucerne. (DCP – Digestible Crude Protein)

The roughages are further classified into two major group as:

- **Green / succulent roughages** – They contain about 60-90 percent moisture eg. Pastures, cultivated fodders, tree leaves, root crops and silages.
- **Dry roughages** – They contain about 10-15 percent moisture e.g. Straw, Hay and kadbi.

Concentrates

- These are the feedstuffs which contain less than 18 percent crude fibre and more than 60 percent TDN. They are less bulky and have higher digestibility. They are concentrated source of nutrients and therefore, they have higher nutritive value than roughages.

- Energy Rich Concentrates – e.g. Cereal grains, cereal grain byproducts, Roots and tubers.
- Protein Rich Concentrates – i) Plant origin e.g. Oilseed cake, pulse chuni, Brewer's grains and yeast. ii) Animal origin e.g. Fish meal, Meat meal, Blood meal

Feed Supplements

- Feed supplements are the compounds used to improve the nutritional value of the basal feeds so as to take care of any deficiency.
- Commonly used feed supplements are:
  - Vitamin supplements e.g. Rovimix, Vitablend, Arovit etc.
  - Mineral supplements e.g. Minimix, Milk min, Nutrimilk, Aromin etc.

Feed Additives

- Feed additives are the non-nutritive substances usually added to basal feed in small quantity for the fortification in order to improve feed efficiency and productive performance of the animals.
- Some commonly used feed additives are as below:
  - Antibiotics e.g. Terramycin, Zinc bacitracin, Flavomycin etc.
  - Enzymes e.g. Amylase, lipase, protease, pepsin etc.
  - Hormones eg. Estrogen, progesterone, hexosterol etc.
  - Thyroprotein e.g. Iodinated casein.

4.Introduction to poultry industry in India

- Poultry sector in India broadly divided into two sub-sectors:

Organized sector:

- Needs conducive environment to grow for which policy support & intervention is required mainly for disease surveillance, Drug residue and drug/ vaccine quality control, standardization & quality control of poultry feed, eggs & meat, Application of HACCP (Hazard Analysis and Critical Control Point) and Good Manufacturing Practices for compliance to WTO & CODEX norms and gradation, value addition, brand promotion & export boosting etc.

Unorganized sub sector:

- The unorganized sector also referred to as backyard poultry plays a key role in supplementary income generation and family nutrition to the poorest of the poor.
- However, until now there has been little support to this sector
- A part of the unorganized sector is **the Transitional Small & Marginal sub-sector**: Due to Government initiatives for entrepreneurship development, small/ marginal units are now coming up. However, these can sustain only if they operate in a clustered manner

Growth Drivers and Emerging Trends for eggs and poultry

- In India, poultry sector growth may be attributed to many factors like rising incomes and a rapidly expanding middle class, together with the emergence of vertically integrated poultry producers that have reduced consumer prices by lowering production and marketing costs.
- Integrated production, market transition from live birds to chilled and frozen products, and policies that ensure supplies of competitively priced corn and soyabean are keys to future poultry industry growth in India. Further, disease surveillance, monitoring and control will also decide the fate of this sector.
- Concurrently, India's unorganised and backyard poultry sector is also one of the potent tools for subsidiary income generation for many landless/ marginal farmers and also provides nutritional security to the rural poor.
- These achievements and growth rates are still being sustained despite the ingress of avian influenza which was a severe setback for the industry, showing the resilience of the subsector, perseverance of the private sector and timely intervention by the Government.
- To assess the future trends, we have to review the past planning and present scenario to extrapolate the future. The externalities and variables are often unprecedented and sudden. Both empirical and statistical methods need to be accounted for while making any predictive assumptions.

Indian Poultry Farm Market: Drivers

- Increasing Incomes Coupled by Changing Food Habits
- Large Unpenetrated Market
- Growth in the Food Services Market
- Growth in the Bakery Foods Market
- Problems associated with the poultry industry
- Feed ingredients and other logistics cost
-

S. No.	Details	Poultry
1	Group	Flock
2	Adult Male	Cock
3	Adult Female	Hen
4	Young Male	Cockrel
5	Young Female	Pullet
6	New-born	Chick
7	Meat	Chicken
8	Castrated Male	Capon
9	Mating	Serving
10	Parturition	Hatching
11	Female with its offspring	Suckling

5.Common terms pertaining to poultry production and management.

1. **Artificial Incubation:** It is the hatching of eggs through a mechanical equipment such as incubator
2. **Auto-sexing-** Sex differentiation at day-old age on the basis of some visual characters such as colour of down (fluff), early feathering, etc
3. **Brooder-** An appliance to supply artificial heat to young ones of poultry from day-old to till warmth is required is known as brooder.
4. **Brooder chick:** A young chick of 0 to 8 weeks of age.
5. **Broody hen:** A hen which tends to sit on the egg to hatch them.
6. **Broiler-** It is also called as frier, which is young chicken of either sex, usually 6 to 7 weeks of age (40-45 days), weighing 1.25 to 1.40 kg; that is tender meated with soft, pliable, smooth textured skin and flexible breast bone. Broiler is suitable for broiling or frying,
7. **Brood:** A group of (baby) chicks from one hatch.
8. **Brooding-** Rearing of baby chicks with careful management from day-old up to warmth is required, usually 3 to 4 weeks in broilers and 6/7 weeks in layer type chicks is known as brooding.
9. **Candling-** The visual examination of egg by holding it in between the eye and source of light to test internal quality and freshness of egg.
10. **Beak trimming (Debeaking)-**Removal of a part of upper and lower mandible (beak) by a sharp knife and cauterizing by a soldering rod in order to minimize feed wastage and to reduce the risk of feather pecking/cannibalism. This debeaking is very common in practical poultry farming.
11. **Cannibalism-** It is a vice (bad habit) which may occur in chicken of all ages. It includes feather plucking; vent, head, wing, intestine and toe picking. Causing injuries to comb and wattle due to infighting, egg eating is also one type of cannibalism.
12. **Chicken-** The domestic fowl (Callus domesficus) usually reared as a farm bird kept for commercial purpose includes improved exotic breeds and desi fowls also.
13. **Culling**-Separation and removal of unproductive or otherwise undesired birds from the flock which are untrue to its type, judged on productive and physical characteristics.

14. **Coccidiosis-** Disease of fowl caused by a microscopic protozoa that causes diarrhea, thriftiness or death. Occurs most frequently in chicks older than three weeks and in young adults. Transmitted by chicken waste. Prevented by many commercially available coccidiostats that can be added to feed.
15. **Egg-** The reproductive body produced by female of birds, more or less oval in shape, enclosed in hard calcareous shell within which embryo develops on fertilisation, containing nutrients for development of embryo.
16. **Hen-day-production**: This is arrived by dividing total eggs laid in the season by the average number of birds in the house.
17. **Hen-housed-average**: This is arrived at by dividing the total number of eggs laid in the season by the number of birds originally placed in the house. No deductions are made for any losses from the flocks.
18. **Grower feed-** Commercially available feed formulated for adolescent, growing chickens. Usually used from nine to 20 weeks.
19. **Layers**- Mature female chickens kept for egg production. Also known as laying hens.
20. **Laying feed-** Commercially available feed formulated for laying hens. Usually given to chickens beginning at 20 weeks of age.
21. **Marek's disease-** A viral disease common in chickens. Commonly prevented by a vaccination administered immediately after chicks hatch.
22. **Newcastle disease-** A viral respiratory disease common in chickens. Newcastle disease can spread very quickly within a flock. Commonly prevented with a series of vaccinations.
23. **Ornithology-** The study_ of science of birds other than poultry is known as ornithology.
24. **Poultry-** The domesticated species of birds reared for eggs, meat, feathers, etc. includes chicken, ducks, turkey, quail, geese, guinea fowl, etc.
25. **Starter feed-** Pre-mixed commercial food for chicks, commonly available at feed or farm stores. According to University of Florida animal science experts, starter feeds usually contain about 20 percent crude protein and the vitamins and minerals needed by chicks. These feeds usually are also medicated. Should be fed to chicks for the first six to eight weeks of life.

6.Concept of mixed farming and its relevance to socio-economic conditions of farmers in India.

- Mixed farming can be defined as the combination of two or more independent agricultural activities on the same farm.
- It's to be an agricultural system in which farmers perform different agricultural practices together, such as cash crops and livestock so as to enhance income through different sources and to adjunct land and labor demands across the year.
- The mixed farming could be in the form of the crop-livestock, crop-forestry, crop-horticulture fish-pig, fish-duck, and paddy-fish etc. Mixed farming system is helpful in decreasing the cost of production per unit area, increasing income and productivity and reducing the risk of farmers.

Factor affecting of mixed farming

- It exists in a lot of forms depending on external and internal factors.
- External factors include
  - weather patterns
  - market prices
  - political stability
  - technological developments
- Internal factors are associated with
  - local soil characteristics
  - composition of the family and farmers' skill

Advantage of Mixed farming

- In this type of farming, the fields are never left uncultivated. They would be producing one or other crops continuously.
- Continuous production of crops / livestocks will improve the productivity of the land.
- The profit of farmers will be improved as the land will be under production throughout the year.
- One type of farming can support the other one in the mixed farming which reduces the cost cultivation.
- When animal husbandry and crop farming is induced together the crop will help animal for fodder and in return, the waste generated by the animal can be used as a manure for crops.
- Since, recycling of waste generated from plants and animals is used internally; there would be less requirement of input.

Disadvantages of Mixed farming

- This type of farming is difficult to maintain than the monoculture type. This is because of more number of activities involved in mixed farming. Monitoring and maintenance of farming is difficult.

- There is also a chance that a mistake in one crop will affect the other one.
- The farmer must have complete knowledge of all the enterprises involved in mixed farming as there are many activities involved in it.
- The main drawback of mixed farming is its limited capacity to grow a crop. If multiple crops are grown then commercial cultivation of one will be difficult due to the limitation of space Method of mixed farming system

7.Animal husbandry methods in India

- Animal husbandry is the rearing of domestic animals or livestock and includes all aspects of breeding, caring, feeding and management.
- Animal husbandry may be divided into the following categories – **cattle husbandry, sheep husbandry, pig husbandry, goat husbandry, horse, camel and rabbit husbandry**. Agriculture is intimately connected with livestock. Improvement of agriculture requires the improvement of livestock.
- They are the main source of draught power in agriculture operations and rural transportation. They provide essential food like milk, milk products and meat. It also provides products such as hides, bones, blood and organic manures.

Cattle:

- Cattle are considered to have been one of the first animals domesticated by man for agricultural purposes. They are raised as livestock for meat called beef, dairy products (milk and milk products), and leather and as draught animals (for pulling carts, plough fields, etc.)

Improvement of Cattle:

- Animal breeding is an integration of three major areas – artificial insemination, embryo transfer and embryo micro manipulation techniques, biotechnology and genetics engineering.
- *The system of breeding can be grouped into two types:*
    - **Inbreeding.**
    - **Outbreeding:**

Outbreeding:

- Outbreeding is the mating of unrelated animals and includes hybridization, grading up, crossbreeding and outcrossing.
- Hybridization: Hybridization is the mating between two distinct species.
- Grading Up: Grading up is the practice of breeding pure bred sires of a given breed with native females. Continued crossing with the pure bred sire would make the off-springs having characteristics closer to the pure breed.
- Cross Breeding: Cross breeding is the mating of pure bred animals of two distinct breeds. Cross breeding brings together divergent germplasms. It is usually done for increasing the yield. Indian cows are cross bred with European breeds. Sunandini and Karan Swiss are examples of some breeds developed at the National Dairy Research Institute in Kerala and Karnal, respectively.

- Outcrossing: Outcrossing is the crossing of unrelated animals within the same breed.

Inbreeding:

- Inbreeding is the mating of individuals that are related and includes line breeding and close breeding.
- Close Breeding: Mating of a brother to sister, of a sire to his daughter, or dam to her son is known as close breeding.
- Line Breeding: Line breeding is the mating of animals with wider degree of relationships than those of close breeding. It is mating of cousins and other distantly related individuals.
- The most important step in animal breeding is the selection of animals. The animal is carefully examined for physical defects such as crooked legs, abnormal udders or milk producing gland, etc. Animals that suffer from heritable defects such as dwarfism in cattle are avoided. Records of performance or production should be considered in the selection of breeding animals.

Animal breeding

- Artificial breeding is done through artificial insemination, which is the method of collecting semen from high quality bulls and inseminating the cows.
  Artificial Insemination
- Artificial insemination is the technique in which semen with living sperms is collected from the male and introduced into female reproductive tract at proper time with the help of instruments. This has been found to result in a normal offspring. In this process, the semen is inseminated into the female by placing a portion of it either in a collected or diluted form into the cervix or uterus by mechanical methods at the proper time and under most hygienic conditions. The first scientific research in artificial insemination of domestic animals was performed on dogs in 1780 by the Italian scientist, Lazanno Spallanzani. His experiments proved that the fertilizing power reside in the spermatozoa and not in the liquid portion of semen.

The advantages of AI method are as follows:

  - It ensures good quality progeny.
  - It is an economic procedure as semen from one bull can inseminate several thousand cows.
  - This process does not require transportation of the bull, as this method requires the transportation of only the semen.

Embryo Transfer

- The female is artificially inseminated to produce 4 – 0 embryos. The embryos are removed and transplanted into surrogate mothers. This is known as embryo transfer. Embryos and semen can be frozen at -196°C and maintained in artificial media for future use.
- *Nutritional Requirement:* The cattle requires the following nutrients – water, proteins, carbohydrates, fats, minerals and vitamins.
- All feeds for the dairy cattle are classified into two main groups – roughage and concentrates.

Fisheries

1. Common terms pertaining to fish production.

- **Fish**: - is a cold-blooded aquatic organism that breathes with gills and swims with fins, they are categorized as Finfish and Shellfish.
- **Aquaculture:** - The farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc
- **Pisciculture**: The cultivation of fishes in controlled aquatic environment.
- **Ichthyology: -** It is the branch of science dealing with the study of fishes, commercial aspects of fishes, including the behaviour of environment, population dynamics etc.
- **Fishing:** -this term is used interchangeably with “collecting” and “harvesting” to describe the act of removing sea cucumbers from the wild for commercial or subsistence purposes.
- **Brackish water**: - Water of intermediate salinity between seawater & freshwater.
- **Active fish:** - Fish that is feeding actively and striking aggressively.
- **Angleworm:** - Any live earthworm placed on a fishing hook.
- **Angling:** - Refers to recreational catching of fish by hook and line.
- **Fry:** - Immature fish from the time they hatch to the time they become fingerlings.
- **Fingerling:** - A young fish about a finger long, usually 2 inches in length.
- **Bag limit:** - Also known as daily bag limit. The number or size of a species that a person can legally take in a day or trip
- **Eutrophication:** - Water becomes enriched in dissolved mineral nutrients (particularly phosphorus and nitrogen) that stimulate the growth of aquatic plants and enhance organic production of the water body. Excessive enrichment may result in the depletion of dissolved oxygen and eventually to species mortality and replacements.
- **Fecundity**: - Potential reproductive capacity of an organism or population expressed in the number of eggs (or offspring) produced during each reproductive cycle.
- **Fish stock:** - The living resources in the community or population from which catches are taken in a fishery. In a particular fishery, the fish stock may be one or several species of fish but here is also intended to include commercial invertebrates and plants.
- **Fishing mortality:** - A technical term which refers to the production of the fish available being removed by fishing in a small unit of time. E.g., a fishing mortality rate of 0.2 implies that approximately 20% of the average population will be removed in a year due to fishing.
- **Brood fish:** - A large sexually mature fish capable of breeding.
- **By-mortality: -** It is the mortality of marine organisms from injuries caused by encounters with the fishing gear during the fishing process.
- **Carp:** - Member of minnow family.
- **Demersal:** - living at or near the bottom of a body of water.
- **Marine protected area:** - a portion of the marine benthos and water, with its associated biota, reserved to protect part or all of the designated environment. The protection may allow for regulated levels of extraction (fishing) of plants and animals.

- **Overfishing:** - A generic term used to refer to the state of a stock subject to a level of fishing effort or fishing mortality such that a reduction of effort would, in the medium term, lead to an increase in the total catch. Often referred to as overexploitation and equated too biological overfishing, it results from a combination of growth overfishing and recruitment overfishing and occurs often together with ecosystem overfishing and economic overfishing.
- **Pelagic fish:** - Fish that spend most of their life swimming in the water column with little contact with or dependency on the bottom. Usually refers to the adult stage of a species.
- **Phytoplankton: -** Derived from the Greek words Phyto (plant) and plankton (made to wander or drift), phytoplankton are microscopic organisms that live in watery environments, both salty and fresh.
- **Snagging: -** A method of catching fish by jerking an un-baited hook through water.
- **Spawning stock: -** Mature part of a stock responsible for the reproduction. The portion of an overall stock having reached sexual maturity and able to spawn. Often conventionally defined as the number or biomass of all individuals beyond age at first maturity or size at first maturity, that is beyond the age or size class in which 50% of the individuals are mature.
- **Stocking:** - The practice of releasing artificially reared young fish into a pond, lake or river. These are subsequently caught, preferably at a larger size.
- **Turbidity**: - Turbidity is the measure of relative clarity of a liquid, number of suspended particles and dissolved dirt in the water which give the water a brown color. Secchi disc is used to measure turbidity of water.

Terminology of fish migration

The following terms and definitions of fish migrations proposed by Meyer (1949) have been generally adopted:

- **Diadromous: -** Truly migratory fishes which migrate between the sea and freshwater.
- **Anadromous: -** Diadromous fishes which spend most of their lives in the sea and migrate to freshwater to breed (salmon, sea trout, shad, sea lampreys, sturgeons).
- **Catadromous: -** Diadromous fishes which spend most of their lives in freshwater and migrate to the sea to breed (eel, Salangidae, Galaxidae, Retropinnidae).
- **Amphidromous: -** Diadromous fishes which migrate from the sea to freshwater or vice versa, but not for the purpose of breeding (some Exocidae, Perca fluviatilis, some Mugilidae).
- **Potamodromous: -** Truly migratory fishes, the migrations of which occur wholly within freshwater (trout, bream, Coregonoids).
- **Oceanodromous: -** Truly migratory fishes which live and migrate wholly in the sea (cod, herring, capelin, tuna, mackerel).

Classification of fish	Lives in	Breed in	Example
Diadromous	Migrate between sea to freshwater, lives partly in sea water and partly in freshwater.		-
Amphidromous	Migrate from sea to freshwater or vice-versa		Exocidae, Mugilidae
Potamodromous	Live and migrate within fresh water		Trout, bream
Oceanodromous	Live and migrate within sea water		Cod, tuna, Mackerel
Anadromous	Sea water	Freshwater	Salmon, sea trout, sea lampreys
Catadromous	Freshwater	Sea water	Eel, Salangidae

2.Fisheries resources, management and exploitation

Aquaculture practices are classified, depending upon the different aspects and situations involved in the culture practice. Some major classifications are given below based on the different factors involved in aquaculture.

On the basis of salinity: -

Freshwater farming	Brackish water farming	Marine water farming
Farming of aquatic animals and plants in **zero saline water (<0.5 ppt),** mostly fresh water farming is inland based.	Brackish water is a mixture of sea water and freshwater with a **salinity less than 30ppt**. All estuaries, backwaters, creeks and mangrove waterways.	Farming of aquatic animals and plants in **sea water (>30ppt) is** commonly known as marine water farming or mariculture.
E.g., Catla, Rohu, Mrigal, Silvercarp, Grass carp, Common carp and Fresh water prawn.	**E.g., Shrimps, crabs and mollusks offer a wide scope for farming in brackish water**	**E.g., Shell fishes are done in open sea by installing cages.**

On the basis of intensity: -

Extensive fish farming system	• Least managed form of fish farming, in which little care is taken. • This system involves large ponds measuring 1 to 5 ha in area with stocking density limited to only less than 5000 fishes/ha. • No supplemental feeding or fertilization is provided. • Fish depends only on natural foods. • Yield is poor (500 to 2 ton/ha) and survival is low. • The labor and investment costs are low and this system results in minimum income.
Semi-intensive fish farming system	• This system is more prevalent and involves rather small ponds (0.5 to 1 hectare in area) with higher stocking density (10000 to 15000 fish/ha). • In this system care is taken to develop natural foods by fertilization with or without supplemental feeding. • Major food source is natural food. • Yield is moderate (3 to 10 ton/ha) and survival is high.
Intensive fish farming system	• It is the well-managed form of fish farming, in which all attempts are made to achieve maximum production of fish from a minimum quantity of water. • This system involves small ponds/tanks/raceways with very high stocking density (10-50 fish/m^3 of water). • Fish are fed completely formulated feed. • Good management is undertaken to control water quality by use of aerators and nutrition by use of highly nutritious feed. • The yield obtained ranges from 15 to 100 ton/ha or more. • Although the cost of investment is high, the return from the yield of fish exceeds to ensure profit.

On the basis of fish species: -

Monoculture	Polyculture
• Only one fish species is reared in a culture system. • The major fish varieties reared are trout, tilapia, catfishes, carps, shrimp etc. • Monoculture of high-value, market-oriented fish species in intensive system is a common practice throughout the world. • Supplementary feeding is compulsory to ensure production.	• Two or more different fish species are farmed or culture of fish along with other aquatic animals like shrimp or prawn. • Species with different habitats and food preferences are stocked together in such densities that there will be almost no competition for food or space. • Gives higher yield than monoculture under the same conditions for freshwater carp farming.

On the basis of enclosure: -

Pond culture	• Water is maintained in an enclosed area by artificial construction of dike/bund, where aquatic animals are stocked and grown. • Ponds are usually filled by rain, canal water and by manmade bores. • They differ widely in shape, size, topography, water and soil qualities.
Cage culture	• Rearing of fish from juvenile stage to commercial size in a volume of water enclosed on all sides including bottom, while permitting the free circulation of water. • Readily adapted to water areas which cannot be drained. • In principle, almost every cultivable species of fish can be cultured in cages, such as carps, tilapia, trout, catfishes, etc. depending on socioeconomic, ecological and technical suitability.
Pen culture	• It is defined as raising of fish in a volume of water enclosed on all sides except bottom, permitting the free circulation of water at least from one side. • Considered as a hybrid between pond culture and cage culture. • Mostly shallow regions along shores, banks of the lakes and reservoirs are used in making pen/enclosure using net/wooden materials where fish can be raised. • In a fish pen, the bottom of the lake forms the bottom of the pen.
Race-way culture	• It is defined as raising of fish in running water. • It is a high production system in which fishes are grown in higher stocking density. • Raceways are designed to provide a flow-through system to enable rearing of much denser population of fishes. • Raceway ponds are basically of two types: • Linear type: Ponds arranged in sequence, volume of water entering each pond is larger and as the same water is used repeatedly from pond to pond, occurrence of disease in initial ponds may directly affect the other connected ponds

	• Lateral type: Ponds laid out in lateral or parallel type, the volume of water entering each pond is smaller but a fresh supply of water is always ensured, and no transfer of disease from one pond to another.

Pre-stocking management

Management before stocking is pre stocking management. Broadly it can be said that all the management practices involved in fish culture before stocking of fry in order to prepare the water body and its surrounding environment for living and growth of the fry.

- Preparation of pond
- Eradication of undesirable fishes and aquatic weeds
- Liming of pond
- Water filling and
- Basal manuring and fertilization

On Stocking management

- After 15 days of application of fertilizers, pond will be ready for stocking.
- Fingerlings of approx.. 50-100 g size should be used for stocking.

1. Selection of species: - based on fast growth rate, good market value, acceptability and adaptability.
2. Quality, size and number of fish species to be stocked.

Post-stocking management

This phase includes the activities to be undertaken from stocking of fingerlings up to the final harvesting of fish from the pond. The activities are manuring, feeding, growth and health monitoring, water quality monitoring and harvesting.

Supplementary feeding

- The need for supplementary feeding in aquaculture depends on the intensity of fish culture.
- After certain level of fish biomass increase, the available natural food organisms in a pond are not sufficient to support further growth of fish.
- Oil cakes, rice / wheat beans, grain fodders and other agricultural by-products and available slaughter house by-products (blood, rumen content, Viscera etc) may be utilized as fish feed ingredients.
- Feeding is the most expensive operation in aquaculture.
- Care has to be taken to supply the required quantity and quality of feed to the species culture.
- Under feeding will result in poor growth of fishes whereas, overfeeding will increase the cost of feeding.
- Hence, feeding assumes prime importance in improving the yield and the profitability of aquaculture.

Regular sampling of fish

In a proper fish production management system, periodic sampling at regular internal is very important with a view to

- Checking the health condition of the fish.
- Monitoring the growth rate of fish.
- Estimating survival and mortality of fish in the pond.
- Calculating the quantity of supplementary feed to be applied in accordance with the increasing biomass of fish.

Harvesting of fish

- Harvesting of fish means the complete removal of fish from the pond at the end of production.
- A single stocking and a single harvesting are the common practice in existence.
- The technique of partial harvesting and restocking is now being practiced and has been found to yield better results in terms of fish production per unit area.
- Bigger size fishes should be harvested and sold in batches and the pond should immediately be restocked with the same number of fishes of such species.
- Harvesting is done when fish attains an average weight of 800-1.25 kg

3. Aquaculture- Inland and marine

Aquaculture: -

- According to FAO, Farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants.
- Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators etc.

Activities constituting Aquaculture:

- Rearing of fry, spat, post larvae etc., in hatcheries,
- Stocking of ponds, cages, tanks, raceways and temporary savages with wild caught or hatchery reared juveniles to produce marketable fish/shellfish/aquatic plants/other aquatic animals.
- Culture in private tidal ponds.
- Rearing molluscs to market size from hatchery produced spat, transferred natural spat fall or transferred part.
- Stocked fish culture in paddy fields.
- Harvesting planted or suspended seaweed.
- Valli culture (Culture in coastal lagoons).

Categorization of Fish by their habitat: -

- **Freshwater Fish**: Fish that spend most or all of their life in freshwaters, such as rivers and lakes, having a salinity of less than 0.5 ppt.
  They may be divided into
  - **Coldwater Fish (5 – 20°C) examples: Mahseer, Trout, etc.**
  - **Warmwater Fish (25–35°C) example: Carps, Catfish, Snakeheads, Featherbacks, etc.**
- **Brackish water Fish:** Fish that can tolerate a wide range of salinity (0.5 – 30 ppt) and live-in backwaters, estuaries and coastal waters.
  Example: **Mullet, Milkfish, Seabass, Pearl spot, Mudskipper, etc.**
- **Marine Fish:** Fish that spend most or all of their life in seawater, such as seas and oceans, having salinity above 30 ppt.
  Example: **Sardines, Mackerel, Ribbonfish, Anchovies, Grouper, Cobia, Tuna, etc.**

Important fish and their feeding habits: -

Species	Feeding habits	Feeding zones
Catla	Zooplankton feeder	Surface feeder

Mrigal	**Detritivorous**	**Bottom feeder**
Rohu	**Phytoplankton feeder**	**Column feeder**
Silver carp	**Phytoplankton feeder**	**Surface feeder**
Grass carp	**Herbivores**	**Surface, column and marginal**
Common carp	**Detritovorous/Omnivorous**	**Botton feeder**

Inland Aquaculture

- The inland water bodies are widely used for culture and capture fisheries.
- The inland fish production has increased mainly due to contribution from fresh water aquaculture.

Out of the total inland aquaculture production, **Indian Major Carps** are the most cultured freshwater fish followed by **Exotic Carps, Minor Carps, Tilapia, Catfish, Freshwater Prawns and Trout,** etc.

The Inland Fisheries of India may be classified as: -

i. Lacustrine Fisheries (Lakes and Reservoirs)
ii. Riverine Fisheries (Rivers and Streams)
iii. Estuarine Fisheries (Estuaries and Backwaters)
iv. Floodplain and Wetland Fisheries
v. Coldwater Fisheries
vi. Ornamental Fisheries
vii. Sport Fisheries
viii. Culture Fisheries (Aquaculture)

Inland aquaculture	
Indian Major carps- Carps which are native to the Indus-Ganges River Systems/Indo-Gangetic Plains of India.	
Catla	***Catla catla***
Rohu	***Labeo rohita***
Mrigal	***Cirrhinus mrigala***
Minor carps- smaller carps.	
Reba	***Cirrhinus reba***
Bata	***Labeo bata***
Fringe-lipped carp	***Labeo fimbriatus***

Calbasu	***Labeo calbasu***
Pengba	***Osteobrama belangeri***
Exotic carps- Carps introduced from other countries.	
Common carp	***Cyprinus carpio***
Grass carp	***Ctenopharyngodon idella***
Silver carp	***Hypophthalmichthys molitrix***
Catfish- Resemble a cat's whiskers.	
Magur/walking catfish	***Clarias magur***
Singhi/stinging catfish	***Heteropneustes fossilis***
Giant river catfish	***Sperata seenghala***
Fresh water Shark	***Wallago attu***
Tilapias- Group of 'Cichlid' fish, native to the African continent.	
Nile tilapia	***Oreochromis niloticus***
Mozambique tilapia	***Oreochromis mozambicus***
Cold water fishes- Temperature of water ranges from 5 - 20°C.	
Golden Mahseer	***Tor putitora***
Common snow trout	***Schizothorax richardsonii***
Rainbow trout	***Oncorhynchus mykiss***
Brown trout	***Salvelinus fontinalis***

Marine Aquaculture

- Marine ecosystem is the largest aquatic system of the planet which includes oceans, coral reefs, and estuaries.
- Oceanographers divided the ocean into many zones according to physical characteristics, based on depth, light and temperature.
- The marine water bodies are mainly used for capture fisheries resources.

2 major zones of the ocean: -

Benthic realm - the entire sea floor or bottom region of the sea called the benthic realm.

Pelagic realm - the watery region above the sea floor is called the pelagic realm.

The important Marine Fisheries can be grouped into the following categories:

1. Surface-water Fish (Pelagic): Sardines, Anchovies, Ribbonfish, Mackerel, Seerfish, Tuna, etc.

2. Mid-water Fish (Pelagic): Bombay Duck, Cobia, Silver Bellies, Horse Mackerel, etc.

3. Bottom-water Fish (Demersal): Perches, Catfish, Pomfrets, Flatfish, Eels, etc.

Marine aquaculture	
Sardines- Sardines are one of the important commercial pelagic schooling fishes in India	
Indian oil sardine	***Sardinella longiceps***
Goldstripe sardine	***Sardinella gibbosa***
Fringescale sardine	***Sardinella fimbriata***
Anchovies- Anchovies are small fish having greenish-blue reflections due to a silver-coloured longitudinal stripe that runs from the head to base of caudal (tail) fin.	
Indian Anchovy	***Stolephorus indicus***
Malbar Anchovy	***Thryssa malabarica***
Mackerels- Mackerel is a common name applied to a number of different species of schooling epipelagic fish of the family Scombridae.	
Indian Mackerel	***Rastrelliger kanagurta***
Indian Chub Mackerel	***Scomber indicus***
Tunas- Tunas (family Scombridae) are among the largest, most specialized and commercially important of all fishes. They are found in temperate and tropical oceans around the world	
Little Tunny	***Euthynnus affinis***
Frigate Tuna	***Auxis thazard***
Yellowfin Tuna	***Thunnus albacares***

4. Post-Harvest Technology

Post-harvest technology is a science applied for protection, conservation, processing, packaging, distribution, marketing, and utilization to meet the food and nutritional requirements of the people in relation to their needs.

Post-Harvest Technology in Fish: -

- Proper handling and processing of fish is required to fulfil the nutritional goals.
- Improvement of the processing and handling of fish in terms of quality, product range and volume results in increased economic activity and employment.
- For stabilizing fish market by providing an outlet for surplus and peak catch even during emergency harvest, thereby ensuring high fishing activities and stable prices.

Handling

After the harvesting, quality of fish depends on how it is handled from the time it is taken out from the water until it reaches the kitchen.

Steps for proper handling of fresh fish: -

1. **Cleanliness**: Proper cleanliness measures should be taken while handling chain.

2. **Care**: Sorting of fish should be done properly before packing.

- Cover fish to protect them from external heat and other elements.
- Drain fish properly before icing.
- Avoid brushing the fish.
- Do not throw, trample or kick the fish.

3. **Cooling:**

- Temperature is the single factor which affect the quality of fish.
- While icing use plenty of ice on top, bottom and side of fish in boxes or shelves.
- Do not over-fill a box of fish, the next box on top will smash the fish below.
- Fish is cooled more quickly when ice cold water is poured on them.

Preservation and processing aids: -

- After being harvested, fish spoils quickly within 12 hours.
- This is due to the high ambient temperature that is ideal for bacterial growth.
- To prevent contamination of the fish, proper hygiene must be ensured.
- Contamination can come from people, soil, dust, sewage, surface water, manure, or spoiled foods.
- Poorly cleaned equipment, domestic animals, pets, vermin or unhygienically slaughtered animals can also be the cause.

- To prevent spoilage of the harvested fish, either the bacteria present in them must be killed or their growth must be suppressed.

Different methods exist to suppress bacterial growth:

1. **Salting**
   - An inexpensive method, and storage can be done at room temperature.
   - Fish quality and nutritional value can be restored after salting.
   - Shelf life is long.
2. **Drying:**
   - Drying is the removal of water from fish.
   - Normally the term 'drying' implies the removal of water by evaporation but water can be removed by other methods.
   - For example: - the action of salt and the application of pressure will remove water from fish. Since water is essential for the activity of all living organisms therefore, its removal will slow down or stops microbiological or autolytic activity and thus can be used as a method of preservation.
   - Methods of drying: - natural drying, mechanical drying, freeze drying, solar drying, etc.

3. **Smoking**
   - Inexpensive method.
   - Little equipment, and fuel must be available.
   - Quality and nutritional value are preserved.
4. **Fermentation:**
   - This method is often inexpensive but the fish taste and odour are radically changed.
   - Storage life varies depending on the product.
   - Nutritional value is often high.
5. **Freezing**

   - Freezing, generally extend the period of storage.
   - In freezing, if the fish is gutted and frozen down to -28 to -30 degree C within two hours of its catch gives effective keeping quality as similar to that of fresh fish.
   - Large fish are frozen by sharp freezing, while small fishes are usually frozen as fillets (lengthwise cuts), steaks (crosscut section) or sticks (lengthwise or crosswise cut from fillet or steaks) are quick frozen.
   - Frozen fish undergo oxidative changes and fatty fish become rancid more quickly so oxidation can be prevented by properly protecting or covering of fish with suitable packaging materials (wrappers) before freezing.

6. **Pretreating**
   - Fish are divided either fat or lean fish by the amount of fat in their flesh.
   - **Fat fish** includes varieties such as **mullet, mackerel, trout, tuna and salmon**.
   - **Lean fish** includes **flounder, cod, whiting, redfish, croaker, snapper, grouper, sheepshead and most freshwater fish.**

- Before freezing, fish can be pretreated to improve the quality of the stored fish.
- Fat fish should be dipped for 20 seconds in an ascorbic acid solution made from 2 tablespoons crystalline ascorbic acid to one quart of cold water to control rancidity and flavor change.

7. Canning:

- Fairly expensive method. It is labor intensive and requires plenty of energy, water and equipment, such as tins or jars with lids, sterilizers and canning machines.
- Packaging is expensive.
- Storage is easy and possible for long periods (below 25 °C / 77 °F).

Forestry

1.Basic concepts of Forest and Forestry

Forest classification –

On the basis of age-

- **Even aged forests (regular forests)** – composed of even aged woods (upto 25% age difference permitted)
- **Uneven aged forests (irregular forests)** – composed of trees of different ages (more than 25% age difference permitted)

On the basis of growing stock –

- **Normal forest** – normal growing stock and sustained yield.
- **Abnormal forest** – do not have normal growing stock and gives irregular yield.

On the basis of regeneration –

- **High forest –** regenerated from seeds.
- **Coppice forests** – regenerated from coppices.

On the basis of species composition –

- **Pure forest** – composed of one single sps with composition not less than 80%.
- **Mixed forest** – composed of two or more sps with atleast canopy of one sps more than 20%.

On the basis of legal legislation-

- **Reserved forests** – rights to all activities like hunting, grazing etc. are banned unless permission is granted for a particular reason.
- **Protected forests** - rights to activities are given to some communities who sustain their livelihood partially or wholly from forest resources.
- **Village forests** – managed and protected by villagers.

Trees suitable for different wastelands

- **Marshy areas** – Bambusa vulgaris (Bamboo), Eucalyptus grandis, Terminalia arjuna (arjun)
- **Sandy areas** – Casuarina equisetifolia (Australian pine), Dalbergia sisoo (shisham), Acacia auriculiformis
- **Acis soils** – Gliricedia sepium, Albizia procera, Ailanthus ultisima
- **Alkaline soils –** Acacia nilotica, Leucaena leucocephala, Terminalia arjuna
- **Saline soils** – Acacia nilotica, Acacia catechu, Prosopsis juliflora
- **Dry clay soils** – Acacia nilotica, Albizia lebbeck, Acacia tortolis
- **High altitude areas** – Grevellia robusta (silver oak), Ailanthus altisima
- **Dry areas** – Prosopsis juliflora, Ziziphus mauritiana (ber), Acacia sps

2.Concepts of social forestry, agroforestry, joint forest management.

Agroforestry – land-use systems involving trees combined with arable crops and/or animals on the same unit of land.

Classification of Agroforestry:

- **Agrisilvicultural systems** –Improved fallow sps in shifting cultivation – planting trees in fallow lands at the end of shifting cultivaton.
- **Taungya system** – raising crops in the initial years of perennial sps.
- **Multispecies tree gardens** – various tree species together for multiple output as food, fodder, wood.
- **Alley cropping**- k/as hedge row intercropping – rows of woody plants with annual crops within them.
- **Multipurpose tree species in farms** – growing of tree species having multiple functions. Eg. Azadirachta indica, Casuarina equisetifolia, Leucaena leucocephala, Cocos nucifera.
- Crop combinations with plantation crops – perennial trees with shrubs (coffee, tea,cocoa).
- **Agroforestry fuel wood production** – fuel wood sps like Prosopsis juliflora, Albizia lebbeck, Casuarina equisetifolia , Dalbergia sisoo on or around agricultural lands.
- **Shelter belts** – rows of trees established at right angles to the prevailing wind direction.

Silvipasture system –

- **Protein bank** – protein rich fodder trees are planted in and round farm lands so as to augment fodder quality and quantity.
- **Live fence of fodder trees and hedges** - fodder trees and hedges are planted along the boundaries which serve as live fence and provide fodder in addition.
- **Trees and shrubs on pasture** – trees and shrubs are scattered irregularly or arranged systematically to supplement forage production.

Agrisilvipastoral system

- **Home gardens** – trees, shrubs, vegetables, pastures and other herbs are grown together in dense mainly in high rainfall areas. Also k/as multi-tier cropping.
- **Social forestry** – application of forest technology to achieve social objectives like improvement of aesthetic value, utilization of available land, development of cottage industries, employment to local communities.
- **Urban forestry** – it is the aggregate of all vegetation and green spaces within the communities that provides benefits vital to enrich the quality of life in urban areas.
- **Joint forest management (JFM)** – protection and reclamation of degraded forest lands through collective action local community and state forest departments for sustainable management and joint benefit sharing of public forest lands.

Miscellaneous

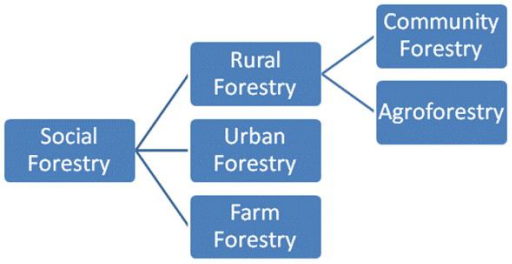
- 'Forest' word has its origin from – Latin language
- Art and science of cultivation of forest crops – Silviculture
- Study of life history and general characters of forest trees – Silvics
- Science dealing with tree age – Dendrochronology
- World Forestry Day – 21 March
- World Environment Day – 5 June
- Father of forestry in India – Dietrich Brandis (from Germany)
- International Council for Research in Agroforestry (ICRAF) is situated in – Nairobi, Kenya (est. 1977)

Social Forestry

- Social forestry is the management and development of forests with afforestation on barren lands to achieve environmental benefit and rural development.
- The term was first used by National Commission on Agriculture, Government of India, in 1976.
- Plantation of trees along railway lines and roadsides, and river and canal banks were carried out. They were planted in village common land, Government wasteland, and Panchayat land.

Types of Social Forestry

- The various types of social forestry systems are shown in the chart below:



Farm forestry

- At present, in almost all the countries where social forestry programs have been taken up both commercially and non-commercial farm forestry is being promoted in one form or the other.
- Individual farmers are being encouraged to plant trees on their own farmland to meet the domestic needs of the family

Urban Forestry

- It is raising and management of trees on private or publically owned lands in and around urban centers for the purpose of improving the urban environment.
- Urban forestry includes the management of individuals as well as groups of trees.
- Rural Forestry
- Rural forestry can be divided into:
- Community forestry
- Agroforestry

Community forestry

- It is the raising of trees on community land and not on private land as in farm forestry. All these programs aim to provide for the entire community and not for any individual.
- The government has the responsibility of providing seedlings, fertilizers but the community has to take responsibility for protecting the trees. Some communities manage the plantations sensibly and in a sustainable manner so that the village continues to benefit.
- Some others take advantage and sell the timber for a short-term individual profit.

Joint Forest Management (JFM)

- It is a partnership involving both the forest departments and local communities in natural forest management. The concept was introduced by Government of India through the National Forest Policy of 1988.
- Under JFM, village communities are entrusted with the protection and management of nearby forests.
- The communities are required to organize forest protection committees, village forest committees, village forest conservation and development societies, etc.
- Example- Controlled grazing of cattle by the Gaddi and Gujjar tribes in the Himalayan states prevents the widespread growth of wild grass, thus contributing towards conservation of biodiversity.
- Bishnoi community of Rajasthan plays a very significant role in ecological conservation.
- Joint conservation effort with the nomadic tribe of Maldharis, living in vicinity of Gir National Park, has contributed to the improvement of lion population.

Name of the Act	Objective	Essential Provisions	Applicability
Forest Conservation Act, 1980	To check further deforestation and conserve forests	- Restricts use of forest for non-forest purpose - Restricts reservation of reserve forests - Regulates diversion of forest land by way of lease to private industries and individuals. - Restricts clear felling of trees - Constitution of Advisory Committee for grant of approval for any of the activities above.	Whole of India except the State of Jammu and Kashmir; The State of Jammu and Kashmir has its own Forest Conservation Act, 1990 on the lines of the FCA 80.
The Biological Diversity Act 2002	Conservation of Biological Diversity, sustainable use of its components and equitable sharing of the	- Provides for establishment of National Biodiversity Authority. - Makes use and regulation of biological diversity subject to the approval of National Biodiversity Authority. - Provides for establishment of State Biodiversity Board - Requires the Central Government to develop National Strategies, plans, programmes for the objectives of the Act.	The Act extends to the whole of India.

	benefits of biological resources	- Requires the Central Govt. to notify threatened species and the State Govt. to notify biodiversity heritage sites. - Mandates every local body to constitute Biodiversity Management Committee. - Provides for establishment of Local Biodiversity Funds.	
Indian Forest Act, 1927	To consolidate laws relating to forests, transit of forest produce and duty leviable on timber and forest produce	- establishes three classes of forests namely Reserve Forest, Protected Forest and Village Forest - has elaborate procedure for constituting the above categories with a detailed process of settlement of rights through the FSO - Ch. V deals with control over forests not being the property of the Government - Chapter VI deals with duty on timber and other forest produce - Ch. VII deals with timber and forest produce in transit. - The object of Ch. VIII is to regulate the rights of the owners in drift and stranded timber. - the power to reserve specific tree species in protected forests	It applies to the territories which, immediately before the 1st November, 1956, were comprised in the States of Bihar, Bombay, Coorg, Delhi, Madhya Pradesh, Orissa, Punj Uttar Pradesh and West Bengal.
National Forest Policy, 1988	It gives major emphasis on the ecological roles of forests, and envisages that the rights and concessions from forests are to be primarily for bona-fide use of communities living within and around the forest areas, especially tribals.	- Maintenance of environmental stability through preservation and restoration of ecological balance. - Conservation of Natural Heritage (existing). - Checking Soil Erosion and Denudation in catchment areas of rivers, lakes, and reservoirs. - Checking extension of sand dunes in desert areas of Rajasthan and along coastal tracts. - Substantially increasing Forest/Tree Cover through Afforestation and Social Forestry. - Taking steps to meet requirements of fuel, wood, fodder, minor forest produces, soil and timber of Rural and Tribal Population. - Increasing the productivity of Forests to meet National Needs. - Encouraging efficient utilization of Forest Produce and Optimum Use of Wood (Timber). - Generation of Work Opportunities, the involvement of Women.	
Joint Forest Management, 1990	To ensure sustainable use of forests to meet local needs equitably while ensuring environmental	As per the provisions of National Forest Policy 1988, the Government of India, vide letter NO.6.21/89-PP dated 1st June, 1990, outlined and conveyed to State Governments a framework for creating massive people's movement through involvement of village committees for the protection, regeneration and development of degraded forest lands.	

	sustainability. The central premise is that local women and men who are dependent on forests at the village level have the greatest stake in sustainable forest management.	This gave impetus to the participation of stakeholders in the management of degraded forests situated in the vicinity of villages. This gave birth to JFM. JFM is a forest management strategy under which the government (represented by the Forest Department) and the village community enter into an agreement to jointly protect and manage forestlands adjoining villages and to share responsibilities and benefits (Government of India, 2002)	

Agriculture Extensions:

1.Introduction Principles and Methods of extension

- 'Extension' is derived from Latin word, 'ex' – meaning 'out' and 'tensio' meaning 'stretching'. The word extension came to used originally in USA in 1914. The word "extension" signifies an out- of school system of education.
- Extension means that type of education, which is stretched out, to the people in rural areas, beyond the limits of the educational institutions to which the formal type of education is normally confined.
- Extension education is an applied behavioral science dealing with the desirable changes in the behavioral complex of human beings, through various strategies and programmes, by applying the latest scientific and technological innovations.
  Or
- Extension education is an applied social science consisting of relevant content derived from physical, biological and social sciences and in its own process synthesized into a body of knowledge, concepts, principles and procedures oriented to provide non-credit out of school education largely for adults. - Paul Leagans (1971).
- J.P Leagans is the father of extension educations in India.
- In India, the study of extension education as a course study was first time started at Sabour (Bhagalpur), Bihar in 1956.
- Research ↔ Extension worker ↔ Farmer

Principles of Extension Education

1. Principle of interest and need: means it is based on the needs and interests of the people.
2. Principle of cultural difference: based on the cultural background of the people.
3. Principle of participation.
4. Principle of adaptability: Extension programmes should be flexible.
5. The grass roots principle of organization: means programmes fit in with the local conditions so that more and more people would participate.
6. The leadership principle: Programme is based on full utilization of local leadership.
7. The whole family principle
8. Principle of co-operation: Rural people cooperate with their village, block and state officials to pursue a common cause.
9. Principle of satisfaction
10. The evaluation principle: To know the merits and demerits of the programme, analytical study is necessary. Therefore, it needs constant evaluation

Important Teaching Methods

According to use and nature of contact:

- **Individual contact or Interpersonal:** In this method face-to-face or person-to-person contact between rural people and extension workers is there. It is a very effective method of teaching. Quantum of feedback available is very high but communication is slow. The

media used in individual contact methods are Farm and home visit, Office calls, Telephone calls, Personal letters, Result demonstration etc.

- **Group contact methods**: Rural people or groups are contacted in a group (20-30 people). Group is usually formed around common interest. Face to Face contact is there. The media used are Method demonstration, conferences, panels (2-8 speakers), symposium (2-5 speakers), Discussion, lecture, meeting, workshops, field trips, tour, Flash cards, training camp, puppet show etc.
- **Mass or community contact methods**: It is more useful for making people are aware of the new agricultural technology quickly. A large number of people (more than 30 persons) are contacted for dissemination of new information. The media used are Radio, Television, Exhibitions, Bulletins, Leaflets, Newsletter, Circular letters, Posters, Folder/ pamphlet, Journal, Movie.

According to Equipment's:- Projected and Non- projected.

1. **Audio Visual Aids**

Audio Aids:

- Tape recorder, Radio, Telephone

Visual Aids:

Projected- Projection is controlled by motor and electricity.

- Slides, Film strips, Silent films

Non – Projected- Here no machinery is required.

- Posters, Charts, Flash cards, Flannel graphs, Bulletin board, Photograph

Audio Visual Aids:

- Projected- Television, motion pictures
- Non- Projected- Drama, Puppet show.

2. **Demonstration**

- Demonstration means showing by doing. The basic principle of demonstration is learning by seeing and doing.
- The concept of demonstration was given by Dr. Seeman A. Knapp.
- There are three types of demonstration:

Method Demonstration:

- It is short- type demonstration
- It's main purpose is to provide only skill
- It does not compare between the old and new techniques or skill. It means comparative study cannot be done.
- It is the oldest form of teaching.
- It is a single practice demonstration and used to show the technique of doing things or carrying out new practices, e.g., how to operate tractor, how to apply fertilizer in the field, method of sowing, soil sampling etc.
- Dr. Seeman A. Knapp is known as father of method demonstration.
- In this demonstration, any process is shown and made clear to people by doing in a sequence starting from the beginning to the end and zealous person is given opportunity for doing.

Result Demonstration:

- It is long type demonstration.
- Comparison between two practices i.e., old and new is always done.
- Results of both practices are shown. It is very effective in adoption.
- It is conducted by a farmer under direct supervision of an extension worker.
- This method is used to show the superiority of practices, such as the use of fertilizers, insecticides, performance of high yielding varieties etc.

National Demonstration:

- National demonstrations are the "front- line demonstration (FLDs)" conducted by researchers on the farmer's field.
- It is composite of both method and result demonstration.

2.Role of Krishi Vigyan Kendra's (KVK) in dissemination of Agricultural technologies.

- Krishi Vigyan Kendra (Farm Science Centre)
- First KVK was started at Pondicherry in 1974 under the administrative control of Tamil Nadu Agricultural University, Coimbatore with the aim of transfer of technical literacy to increase agricultural production.
- The main objective is to impart training (or vocational training) at the kendra (centre) or out of the centre i.e. in the village to the people according to their needs about the Agriculture and allied subjects viz. Animal Husbandry, Fisheries, Horticulture etc.
- The KVK scheme is 100 percent financed by Govt of India and the KVKs are sanctioned to Agriculture universities, ICAR institutes, Government departments and NGOs working in agriculture. The credit for the success of KVK goes to Dr. Chandrika Prasad.
- There are 731 KVKs as in the year 2022 in total.

KVKs undertake following type of activities in the adopted villages-

1. Farm advisory service
2. Training programme for different categories of people
3. Training programme for extension functionaries
4. Front line Demonstrations
5. On farm testing

Ecology and Climate Change:

1.Ecology and its relevance to man, natural resources, their sustainable management and conservation.

- Ecology: - Term was proposed by German Biologist Earnest Haeckel.
- Derived from two Greek words: - Oikos meaning dwelling place/habitat and Logos meaning study.
- Ecology is study of living beings in their natural habitats.
- Ecology can also be defined as a science that deals with the relationships between living organisms with their physical environment and how they interact.
- This includes the abiotic (non-living) environment, lithosphere, hydrosphere (water), atmosphere (air), the cryosphere (the frozen areas) and the biosphere (the living). • Ecosystem: - Living organisms and its environment forms a functional basic unit which was named as ecosystem by Arthur G. Tansley in 1935.

An ecosystem consists of: -

- **Lithosphere:** Ground, rocks, dust, gravel.
- **Hydrosphere**: river, lake, sea (Any waterbody)
- **Atmosphere**: air
- **Biosphere**: vegetation and animals

Structure of an ecosystem: -

Ecosystem has two components: - **Biotic components and Abiotic components**.

- Biotic components consisting of living things. Sub-divided into producers, consumers and decomposers
- Abiotic components consisting of elements that are not alive (gases, solar radiation, temperature, organic and inorganic components, etc.).

Functions of an ecosystem: -

- Function of ecosystem is to provide goods and services that satisfy human needs through natural processes and components, either directly or indirectly.
- Ecosystem functions are subset of ecological processes and ecosystem structures.

Natural Resources and their sustainable management and conservation

- Any material which is valuable and can be transformed into useful product termed as a resource.
- Sum of all physical, chemical, biological and social factors which compose the surroundings of man is referred as environment and each element of these surroundings constitutes a resource on which man draws in order to develop a better life.
- **Concept of natural resources**: - naturally occurring living and non-living entity present in the ecosystem, includes plants, forests, fish and fungi, etc. but also soil, water and minerals.

Approach towards sustainable use of natural resources: -

- Execution of functional environmental and social management systems that can be adapted to the particular feature of each productive landscape.

- Encourage the protection and restoration of natural resources and promote optimization use.
- Require the implementation of systems for treatment before reuse or disposal.
- Encourage soil and water conservation and improved carbon stocks.

Promote 3 R's that is REDUCE, REUSE and RECYCLE.

- Appropriate management of service providers to reduce the harmful impact on natural resources and ecosystem.
- Productivity of various sectors can be increased through an optimum use of natural resources rather an unlimited use in inappropriate manner.
- Identify all nearby endangered natural ecosystem and protected areas in order to implement better conservation practices.
- Avoid destruction and degradation of natural ecosystem, example: - stop deforestation which causes imbalance in surroundings.
- Establish buffer zones to prevent any alteration in natural ecosystems to reduce imbalance.
- Identify endangered and protected species and conserve them in-situ or ex-situ.
- Promote such type of agriculture practices that can restore and increase natural and artificial carbon sink.

Greenhouse Effect

- When the energy from the Sun derives the Earth's weather and climate and heats the Earth's surface, in turn, the Earth radiates energy back into space, some atmospheric gases (water vapour, carbon dioxide and other gases) trap some of the outgoing energy, retaining heat like the glass panels of a greenhouse. These gases are known as Greenhouse gases.
- The greenhouse effect is a process by which the radiation from a planet's atmosphere warms the surface to a temperature above what it would be without this atmosphere.

Six major Greenhouse Gases

- Carbon Dioxide
- Methane
- Nitrous Oxide
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphurhexafluoride (SF6)

Effect of Greenhouse Gases Causes of Greenhouse Gases

- Global warming and Greenhouse Effect

- Global Warming
- Depletion of Ozone
- Layer
- Smog and Air Pollution
- Ozone Depletion

- Acidification of Water
- Bodies
- Industrial Waste and
- Landfills
- Burning of Fossil Fuels
- Deforestation
- Power Generation

Global Warming

- It refers to an increase in average temperature of the Earth.
- The natural events and many human activities are believed to contributing to an increase inaverage global temperature of Earth.
- This is primarily cause by increase in greenhouse gases such as carbon dioxide, methane, nitrous oxide etc.

Impact of Global Warming

- Extreme weather patterns
- Rising sea levels and storms
- Ocean Acidification
- Global dimming

United Nations agencies for Climate change

- UNFCCC – United Nations Framework Convention on Climate Change
- REDD - Reducing Emissions from Deforestation and Forest Degradation
- IPCC – Inter-governmental Panel on Climate Change

Climate Change

- According to IPCC (Intergovernmental Panel on Climate Change), climate change refers to a change in the state of the climate that can be identified by the variability in its properties and that persists for an extended period typically decades and longer.
- Any change in climate over time, due to natural variability or as a result of human activity, due to natural internal processes, external forces, persistent anthropogenic changes in the composition of the atmosphere or in land use.
- According to FAO, Climate change is threatening our ability to ensure global food security for world's population, eradicate poverty and achieve sustainable development.
- Greenhouse gas (GHG) emissions from human activity and livestock are a significant driver of climate change, trapping heat in the earth's atmosphere and triggering global warming.
- Climate change has both direct and indirect effects on agricultural productivity including changing rainfall patterns, drought, flooding and the geographical redistribution of pests and diseases. The vast amounts of CO_2 absorbed by the oceans causes acidification, influencing the health of our oceans and those whose livelihoods and nutrition depend on them.

- FAO is supporting countries to mitigate and adapt to the effects of climate change through a wide range of research based practical programs, as an integral part of the 2030 agenda and the Sustainable Development Goals.

Impact of climate change on agriculture and rural livelihood: -

- In Indian context where agriculture continues to support the livelihoods of more than two thirds of the population. Agriculture and allied sectors are highly sensitive to climate change. It affects livelihoods and human well-being.
- Even slight change in climatic factors like temperature, precipitation or sunlight ultimately affect the agriculture productivity and allied sector activities also.
- South-west monsoon which is grand rainfall period and is critical for the availability of irrigation for agriculture, if there is an increase or decrease in the overall amount of rainfall or delayed monsoon or early cessation of rainfall then it affects the time of sowing of seasonal crops and other cultural operations which are necessary and affect vegetative and reproductive growth of kharif and rabi season crops, ultimately affecting productivity and farmers sustainability.

Adaptation and Mitigation

- To tackle climate change, Mitigation and Adaptation are the two strategies for addressing climate change.
- Mitigation is an intervention to reduce the emissions sources or enhance the sinks of greenhouse gases.
- Adaptation is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC 2001).

Difference between Adaptation and Mitigation: -

Mitigation	Adaptation
It addresses the causes of climate change.	It addresses the impacts of climate change.
To reduce and curb greenhouse gas emissions and minimize the increase of pollutant emissions	To reducing vulnerability to the effects of climate change.
To practice energy efficiency	More secure facility, locations and infrastructure.
Enhance the use of renewable energy	Reforestation and Landscape restoration
Electrification of industrial processes	Flexible and diverse cultivation to be prepared for natural catastrophes

Efficient means of transport implementation to reduce	Research and development on possible catastrophes,

- "Climate system" means the totality of the atmosphere, hydrosphere, biosphere and geosphere and their interactions.
- Climate change in IPCC usage refers to a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity.

Causes of climate change: -

- Major cause - greenhouse effect which ultimately causing global warming in the atmosphere.
- Causes of rising emissions - Burning coal, oil and gas, deforestation, etc.

IPCC: - The Intergovernmental Panel on Climate Change (IPCC)

- Created in 1988 by the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP). Currently, it has 195 members. Headquarters: - Geneva, Switzerland.
- It is the international body for assessing the science related to climate change.
- Objective of the IPCC is to provide governments at all levels with scientific information that they can use to develop climate policies.

UNFCCC: - United Nations Framework Convention on Climate Change

- The UNFCCC entered into force on 21 March 1994. Headquarter: - Bonn, Germany.
- 197 countries that have ratified the Convention are called Parties to the Convention. Preventing “dangerous” human interference with the climate system is the ultimate aim of the UNFCCC.
- It is the parent treaty of the 2015 Paris Agreement.
- The main aim of the Paris Agreement is to keep the global average temperature rise this century as close as possible to 1.5 degrees Celsius above pre-industrial levels.

Conference of the Parties (COP)

- The COP is the supreme decision-making body of the Convention.
- All States that are Parties to the Convention are represented at the COP, at which they review the implementation of the Convention and any other legal instruments that the COP adopts and take decisions necessary to promote the effective implementation of the Convention, including institutional and administrative arrangements.
- The first COP meeting was held in Berlin, Germany in March, 1995.

Kyoto Protocol

- The UNFCCC is also the parent treaty of the 1997 Kyoto Protocol.

- The Kyoto Protocol was adopted on 11 December 1997. Owing to a complex ratification process, it entered into force on 16 February 2005.
- Currently, there are 192 Parties to the Kyoto Protocol.
- After the signing of the UNFCCC treaty, Parties to the UNFCCC have met at conferences ("Conferences of the Parties" – COPs) to discuss how to achieve the treaty's aims.
- In 1997, the Kyoto Protocol was concluded and established legally binding obligations for developed countries to reduce their greenhouse gas emissions in the period 2008–2012.

National Action Plan on Climate Change (NAPCC)

- Government of India launched National Action Plan on Climate Change (NAPCC) on 30thJune, 2008 outlining eight National Missions on climate change.
- It effectively pulls together number of the government's existing national plans on water, renewable energy, energy efficiency agriculture and others – bundled with additional ones – into a set of eight missions.
- The Prime Minister's Council on Climate Change is in charge of the overall implementation of the plan.
    - National Solar Mission
    - National Mission for Enhanced Energy Efficiency
    - National Mission on Sustainable Habitat
    - National Water Mission
    - National Mission for Sustaining the Himalayan Eco-system
    - National Mission for a Green India
    - National Mission for Sustainable Agriculture
    - National Mission on Strategic Knowledge for Climate Change
- NAPCC recognized the role of state and local governments in implementation of the action plan as it was clear that climate change adaptation and mitigation challenges will only be addressed if state governments play an active role in the planning and implementing actions to achieve the objectives of NAPCC.

SAPCC: - State Action Plans on Climate Change

- A process for preparation of State Action Plans on Climate Change (SAPCC) was initiated following the announcement made by then Prime Minister in the conference of state environment ministers held on 18 August 2009.
- The main content of SAPCC as per the common framework document was suggested as follows:
    - Climate profile of the state
    - Assessment of vulnerability to climate change
    - GHG emissions and energy needs
    - Climate change strategy
    - Climate change action plans

(For any doubt & query, you can ask in live classes)