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DEPARTMENT OF AGRICULURAL ENGINEERING

23AGT101 – INTRODUCTION TO AGRICULTURAL ENGINEERING

I YEAR- II SEMESTER

Introduction to Agriculture

INTRODUCTION

- Agriculture is the backbone of Indian economy.
- One of the strongest sectors of Indian economy
- Around 58 % population of India depends on Agriculture.
- Average growth rate of agriculture and allied sector in 2006-07 & 2007-08 has been 4% per annum.
- 140.7 million hectare area is available for sown.
- Major agricultural products include rice, wheat, oilseed, cotton, jute, tea.

AN INTRODUCTION TO AGRICULTURE

A.Terminology

1. Agriculture is derived from Latin words Ager and Cultura. Ager means land or field and Cultura means cultivation.
2. Therefore the term agriculture means cultivation of land. i.e., the science and art of producing crops and livestock for economic purposes.
3. It is also referred as the science of producing crops and livestock from the natural resources of the earth.
4. The primary aim of agriculture is to cause the land to produce more abundantly, and at the same time, to protect it from deterioration and misuse.
5. It is synonymous with farming–the production of food, fodder and other industrial materials.

B. Definitions

Agriculture is defined in the Agriculture Act 1947, as including 'horticulture, fruit growing, seed growing, dairy farming and livestock breeding and keeping, the use of land as grazing land, meadow land, osier land, market gardens and nursery grounds, and the use of land for woodlands where that use ancillary to the farming of land for Agricultural purposes".

It is also defined as 'purposeful work through which elements in nature are harnessed to produce plants and animals to meet the human needs. It is a biological production process, which depends on the growth and development of selected plants and animals within the local environment.

C. Agriculture as art, science and business of crop production

- Agriculture is defined as the art, the science and the business of producing crops and the livestock for economic purposes.
- As an art, it embraces knowledge of the way to perform the operations of the farm in a skillful manner. The skill is categorized as;
- Physical skill: It involves the ability and capacity to carry out the operation in an efficient way for e.g., handling of farm implements, animals etc., sowing of seeds, fertilizer and pesticides application etc.
- Mental skill: The farmer is able to take a decision based on experience, such as (i) time and method of ploughing, (ii) selection of crop and cropping system to suit soil and climate, (iii) adopting improved farm practices etc.

COMMERICAL AGRICULTURE

- **As a science : It utilizes all modern technologies developed on scientific principles such as crop improvement/breeding, crop production, crop protection, economics etc., to maximize the yield and profit. For example, new crops and varieties developed by hybridization, transgenic crop varieties resistant to pests and diseases, hybrids in each crop, high fertilizer responsive varieties, water management, herbicides to control weeds, use of bio-control agents to combat pest and diseases etc.**

- **As the business : As long as agriculture is the way of life of the rural population, production is ultimately bound to consumption. But agriculture as a business aims at maximum net return through the management of land, labour, water and capital, employing the knowledge of various sciences for production of food, feed, fibre and fuel. In recent years, agriculture is commercialized to run as a business through mechanization.**

SCOPE OF AGRICULTURE IN INDIA

- India is blessed with more labourer availability. Since agriculture is the primary sector, other sectors are dependent on agriculture.
- **Total geographical area : 328.848 million ha.**
- **Total reporting area : 304.300 million ha.**
- **Area under cultivation : 143.000 million ha.**
- **Total cropped area : 179.750 million ha.**
- **Area sown more than once : 36.750 million ha.**
- **Area not available for cultivation : 161.300 million ha.**
- **Area under forest : 66.400 million ha**

CROPPING PATTERN

- Mono cropping –one crop /year –tea ,coffee,sugarcane
- Dual cropping –two crop /year /different period-wheat with mustard
- Multiple cropping-more crop /year/different period/bajra/groundnut
- Mixed cropping –more crop /same time /different harvesting period

BRANCHES OF AGRICULTURE

Agriculture has 3 main spheres viz.,
Geoponic (Cultivation in earth-soil),
Aeroponic (cultivation in air) and
Hydroponic (cultivation in water).

Agriculture is the branch of science encompassing the applied aspects of basic sciences. The applied aspects of agricultural science consists of study of field crops and their management (Arviculture) including soil management.

Crop production - It deals with the production of various crops, which includes food crops, fodder crops, fibre crops, sugar, oil seeds, etc. It includes agronomy, soil science, entomology, pathology, microbiology, etc. The aim is to have better food production and how to control the diseases.

Horticulture - Branch of agriculture deals with the production of flowers, fruits, vegetables, ornamental plants, spices, condiments (includes narcotic crops-opium, etc., which has medicinal value) and beverages.

Agricultural Engineering - It is an important component for crop production and horticulture particularly to provide tools and implements. It is aiming to produce modified tools to facilitate proper animal husbandry and crop production tools, implements and machinery in animal production.

Con..

Forestry - It deals with production of large scale cultivation of perennial trees for supplying wood, timber, rubber, etc. and also raw materials for industries. Animal Husbandry - The animals being produced, maintained, etc. Maintenance of various types of livestock for direct energy (work energy).

Husbandry is common for both crop and animals. The objective is to get maximum output by feeding, rearing, etc. The arrangement of crops is done to get minimum requirement of light or air. This arrangement is called geometry. Husbandry is for direct and indirect energy.

Fishery Science - It is for marine fish and inland fishes including shrimps and prawns. Home Science - Application and utilization of agricultural produces in a better manner. When utilization is enhanced production is also enhanced. e.g., a crop once in use in south was found that it had many uses now

- On integration, all the seven branches, first three is grouped as for crop production group and next two for animal management and last two as allied agriculture branches. Broadly in practice, agriculture is grouped in four major categories as,

A. Crop Improvement	(*i*) Plant breeding and genetics (*ii*) Bio-technology
B. Crop Management	(*i*) Agronomy (*ii*) Soil Science and Agricultural Chemistry (*iii*) Seed technology (*iv*) Agricultural Microbiology (*v*) Crop-Physiology (*vi*) Agricultural Engineering (*vii*) Environmental Sciences (*viii*) Agricultural Meteorology
C. Crop Protection	(*i*) Agricultural Entomology (*ii*) Plant Pathology (*iii*) Nematology
D. Social Sciences	(*i*) Agricultural Extension (*ii*) Agricultural Economics
Allied disciplines	(*i*) Agricultural Statistics (*ii*) English and Tamil (*iii*) Mathematics (*iv*) Bio-Chemistry etc.

History of Agriculture

Excavations, legends and remote sensing tests reveal that agriculture is 10,000 years old. Women by their intrinsic insight first observed that plants come up from seeds. Men concentrated on hunting and gathering (Paleolithic and Neolithic periods) during that time. Women were the pioneers for cultivating useful plants from the wild flora. They dug out edible roots and rhizomes and buried the small ones for subsequent harvests. They used animal meat as main food and their skin for clothing.

Farming System

A. Shifting Cultivation

A primitive form of agriculture in which people working with the crudest of tools, cut down a part of the forest, burnt the underneath growth and started new garden sites. After few years, when these plots lost their fertility or became heavily infested with weeds or soil-borne pests, they shifted to a new site. This is also known as Assartage system (cultivating crops till the land is completely worn-out) contrary to the fallow system. Fallow system means land is allowed for a resting period without any crop. In India, shifting cultivation existed in different states, with different names as jhum cultivation in Assam, podu in Andhra Pradesh and Orissa, kumari in Western Ghats, walra in south east Rajasthan, penda bewar in Madhya Pradesh and slash and burn in Bihar.

B. Subsidiary Farming

Rudimentary system of settled farming, which includes cultivation, gathering and hunting. People in groups started settling down near a stream or river as permanent village sites and started cultivating in the same land more continuously, however the tools, crops and cropping methods were primitive.

C. Subsistence Farming

Advanced form of primitive agriculture i.e.,agriculture is considered as a way of life based on the principle of "Grow it and eat it" instead of growing crops on a commercial basis. Hence, it is referred as raising the crops only for family needs.

D. Mixed Farming

It is the farming comprising of crop and animal components. Field crop-grass husbandry (same field was used both for cropping and later grazing) was common. It is a stage changing from food gathering to food growing.

E. Advanced Farming

Advanced farming practices includes selection of crops and varieties, seed selection, green manuring with legumes, crop rotation, use of animal and crop refuse as manures, irrigation, pasture management, rearing of milch animals, bullocks, sheep and goat for wool and meat, rearing of birds by stall feeding etc.

F. Scientific Agriculture (19th Century)

During 18th century, modern agriculture was started with crop sequence, organic recycling, introduction of exotic crops and animals, use of farm implements in agriculture etc. During 19th century, research and development (R&D) in fundamental and basic sciences were brought under applied aspects of agriculture. Agriculture took the shape of a teaching science. Laboratories, farms, research stations, research centres, institutes for research, teaching and extension (training and demonstration) were developed. Books, journals, popular and scientific articles, literatures were introduced. New media, and audio-visual aids were developed to disseminate new research findings and information to the rural masses.

G. Present Day Agriculture (21st Century)

Today agriculture is not merely production oriented but is becoming a business consisting of various enterprises like livestock (dairy), poultry, fishery, piggery, sericulture, apiary, plantation cropping etc. Now, a lot of developments on hydrological, mechanical, chemical, genetical and technological aspects of agriculture are in progress. Governments are apportioning a greater share of national budget for agricultural development. Small and marginal farmers are being supplied with agricultural inputs on subsidy. Policies for preserving, processing, pricing, marketing, distributing, consuming, exporting and importing are strengthening. Agro-based small scale industries and crafts are fast developing. Need based agricultural planning, programming and execution are in progress.

Factors affecting crop production –climatic –edaphic -biotic- physiographic and socio economic factors

I. Internal factors

Genetic factors

The increase in crop yields and other desirable characters are related to Genetic make up of plants

- High yielding ability
- Early maturity
- Resistance to lodging
- Drought flood and salinity tolerance
- Tolerance to insect pests and diseases
- Chemical composition of grains (oil content, protein content)
- Quality of grains (fineness, coarseness)
- Quality of straw (sweetness, juiciness)

The above characters are less influenced by environmental factors since they are governed by genetic make-up of crop.

2. External factors

A.Climatic
B.Edaphic
C.Biotic
D.Phsiographic
E.Socio-economic

A. CLIMATIC FACTORS

Nearly 50 % of yield is attributed to the influence of climatic factors. The following are the atmospheric weather variables which influences the crop production.

1.Precipitation
2.Temperature
3.Atmospheric humidity
4.Solar radiation
5.Wind velocity
6.Atmospheric gases

1. Precipitation

- Precipitation includes all water which falls from atmosphere such as rainfall, snow, hail, fog and dew.
- Rainfall one of the most important factor influences the vegetation of a place.
- Total precipitation in amount and distribution greatly affects the choice of a cultivated species in a place.
- In heavy and evenly distributed rainfall areas, crops like rice in plains and tea, coffee and rubber in Western Ghats are grown.
- Low and uneven distribution of rainfall is common in dryland farming where drought resistance crops like pearl millet, sorghum and minor millets are grown.
- In desert areas grasses and shrubs are common where hot desert climate exists
- Though the rainfall has major influence on yield of crops, yields are not always directly proportional to the amount of Precipitation as excess above optimum reduces the yields
- Distribution of rainfall is more important than total rainfall to have longer growing period especially in drylands

2. Temperature

- Temperature is a measure of intensity of heat energy. The range of temperature for maximum growth of most of the agricultural plants is between 15 and 40°C.
- The temperature of a place is largely determined by its distance from the equator (latitude) and altitude.
- It Influences distribution of crop plants and vegetation.
- Germination, growth and development of crops are highly influenced by temperature.
- Affects leaf production, expansion and flowering.
- Physical and chemical processes within the plants are governed by air temperature.
- Diffusion rates of gases and liquids changes with temperature.
- Solubility of different substances in plant is dependent on temperature.
- The minimum, maximum (above which crop growth ceases) and optimum temperature of individual's plant is called as cardinal temperature.

3. Atmospheric Humidity (Relative Humidity -RH)

- Water is present in the atmosphere in the form of invisible water vapour, normally known as humidity. Relative humidity is ratio between the amount of moisture present in the air to the saturation capacity of the air at a particular temperature.

- If relative humidity is 100% it means that the entire space is filled with water and there is no soil evaporation and plant transpiration.

- Relative humidity influences the water requirement of crops

- Relative humidity of 40-60% is suitable for most of the crop plants.

- Very few crops can perform well when relative humidity is 80% and above.

- When relative humidity is high there is chance for the outbreak of pest and disease.

Solar radiation (without which life will not exist)

- From germination to harvest and even post harvest crops are affected by solar radiation.

- Biomass production by photosynthetic processes requires light.

- All physical process taking place in the soil, plant and environment are dependent on light.

- Solar radiation controls distribution of temperature and there by distribution of crops in a region.

- Visible radiation is very important in photosynthetic mechanism of plants. Photosynthetically Active Radiation (PAR -0.4 –0.7μ) is essential for production of carbohydrates and ultimately biomass.

0.4 to 0.5 μ -Blue –violet –Active
0.5 to 0.6 μ -Orange –red -Active
0.5 to 0.6 μ -Green –yellow –low active

- Photoperiodism is a response of plant to day length Short day –Day length is <12 hours (Rice, Sunflower and cotton), long day –Day length is > 12 hours (Barley, oat, carrot and cabbage), day neutral – There is no or less influence on day length (Tomato and maize).
- Phototropism —Response of plants to light direction. Eg. Sunflower
- Photosensitive –Season bound varieties depends on quantity of light received

5. Wind velocity

- The basic function of wind is to carry moisture (precipitation) and heat.
- The moving wind not only supplies moisture and heat, also supplies fresh CO_2 for the photosynthesis.
- Wind movement for 4 –6 km/hour is suitable for more crops.
- When wind speed is enormous then there is mechanical damage of the crops (i.e.) it removes leaves and twigs and damages crops like banana, sugarcane
- Wind dispersal of pollen and seeds is natural and necessary for certain crops.
- Causes soil erosion.
- Helps in cleaning produce to farmers.
- Increases evaporation.
- Spread of pest and diseases.

6. Atmospheric gases on plant growth

- CO_2–0.03%, O_2-20.95%, N_2-78.09%, Argon-0.93%, Others-0.02%.

- CO_2 is important for Photosynthesis, CO_2 taken by the plants by diffusion process from leaves through stomata.

- CO_2 is returned to atmosphere during decomposition of organic materials, all farm wastes and by respiration

- O_2 is important for respiration of both plants and animals while it is released by plants during Photosynthesis

- Nitrogen is one of the important major plant nutrient, Atmospheric N is fixed in the soil by lightning, rainfall and N fixing microbes in pulses crops and available to plants

- Certain gases like SO_2, CO, CH_4, HF released to atmosphere are toxic to plants

B.EDAPHIC FACTORS (soil)

Plants grown in land completely depend on soil on which they grow. The soil factors that affect crop growth are

1.Soil moisture
2.Soil air
3.Soil temperature
4.Soil mineral matter
5.Soil organic matter
6.Soil organisms
7.Soil reactions

1. Soil moisture

- Water is a principal constituent of growing plant which it extracts from soil
- Water is essential for photosynthesis
- The moisture range between field capacity and permanent wilting point is available to plants.
- Available moisture will be more in clay soil than sandy soil
- Soil water helps in chemical and biological activities of soil including mineralization
- It influences the soil environment Eg. it moderates the soil temperature from extremes
- Nutrient availability and mobility increases with increase in soil moisture content.

2. Soil air

- Aeration of soil is absolutely essential for the absorption of water by roots
- Germination is inhibited in the absence of oxygen
- O_2 is required for respiration of roots and micro organisms.
- Soil air is essential for nutrient availability of the soil by breaking down insoluble mineral to soluble salts
- For proper decomposition of organic matter
- Potato, tobacco, cotton linseed, tea and legumes need higher O_2 in soil air
- Rice requires low level of O_2 and can tolerate water logged (absence of O_2) condition

3. Soil temperature

- It affects the physical and chemical processes going on in the soil.
- It influences the rate of absorption of water and solutes (nutrients)
- It affects the germination of seeds and growth rate of underground portions of the crops like tapioca, sweet potato.
- Soil temperature controls the microbial activity and processes involved in the nutrient availability
- Cold soils are not conducive for rapid growth of most of agricultural crops

4. Soil mineral matter

- The mineral content of soil is derived from the weathering of rocks and minerals as particles of different sizes.
- These are the sources of plant nutrients eg; Ca, Mg, S, Mn, Fe, K etc

5. Soil Organic matter

- It supplies all the major, minor and micro nutrients to crops
- It improves the texture of the soil
- It increases the water holding capacity of the soil,
- It is a source of food for most microorganisms
- Organic acids released during decomposition of organic matterenables mineralisation process thus releasing unavailable plant nutrients.

6. Soil organisms

- The raw organic matter in the soil is decomposed by different micro organisms which in turn releases the plant nutrients
- Atmospheric nitrogen is fixed by microbes in the soil and is available to crop plants through symbiotic (Rhizobium) or non-symbiotic (Azospirillum) association

7. Soil reaction (pH)

- Soil reaction is the pH (hydrogen ion concentration) of the soil.
- Soil pH affects crop growth and neutral soils with pH 7.0 are best for growth of most of the crops
- Soils may be acidic (<7.0), neutral (=7.0), saline and alkaline (>7.0)
- Soils with low pH is injurious to plants due high toxicity of Fe and Al.
- Low pH also interferes with availability of other plant nutrients.

C. BIOTIC FACTORS

Beneficial and harmful effects caused by other biological organism (plants and animals) on the crop plants.

1. Plants

- Competitive and complimentary nature among field crops when grown together
- Competition between plants occurs when there is demand for nutrients, moisture and sunlight particularly when they are in short supply or when plants are closely spaced
- When different crops of cereals and legumes are grown together, mutual benefit results in higher yield (synergistic effect)
- Competition between weed and crop plants as parasites eg:Striga parasite weed on sugarcane crop

2. Animals

- Soil fauna like protozoa, nematode, snails, and insects help in organic matter decomposition, while using organic matter for their living
- Insects and nematodes cause damage to crop yield and considered as harmful organisms.
- Honey bees and wasps help in cross pollination and increases yield and considered as beneficial organisms
- Burrowing earthworm facilitates aeration and drainage of the soil as ingestion of organic and mineral matter by earth worm results in constant mixing of these materials in the soils.
- Large animals cause damage to crop plants by grazing (cattle, goats etc)

D. Physiographic factors:

•Topography is the nature of surface earth (leveled or sloppy) is known as topography.

Topographic factors affect the crop growth indirectly.

•Altitude –increase in altitude cause a decrease in temperature and increase in precipitation and wind velocity (hills and plains)

•Steepness of slope: it results in run off of rain water and loss of nutrient rich top soil

•Exposure to light and wind: a mountain slope exposed to low intensity of light and strong dry winds may results in poor crop yields (coastal areas and interior pockets)

E. Socio-economic factors

•Society inclination to farming and members available for cultivation

•Appropriate choice of crops by human beings to satisfy the food and fodder requirement of farm household.

•Breeding varieties by human invention for increased yield or pest & disease resistance

•The economic condition of the farmers greatly decides the input/ resource mobilizing ability (marginal, small, medium and large farmers)

TYPES OF FARMING IN INDIA

You know that India has diversified topography. You have already learnt about it in the lesson on physiography of India. The country has Himalayan mountain ranges extending from Jammu and Kashmir in the west to Arunachal Pradesh in the North-East. They have hill ranges in the form of Eastern Ghats and Western Ghats.

Apart from variation in landform, the country has varieties of climatic conditions, and soil types. These physical variations along with other factors like availability of irrigation, use of machinery, modern agricultural inputs like High Yielding Varieties (HYV) of seeds, insecticides and pesticides have played their respective roles in the evolution of different farming practices in India. Some of the major types of farming are discussed below.

1.Subsistence and commercial farming:

Majority of farmers in India practises subsistence farming. This means farming for own consumption. In other words the entire production is largely consumed by the farmers and their family and they do not have any surplus to sell in the market. In this type of farming, landholdings are small and fragmented. Cultivation techniques are primitive and simple. In other words there is a total absence of modern equipments like tractors and farm inputs like chemical fertilizers, insecticides and pesticides. In this farming, farmers mostly cultivate cereals along with oil seeds, pulses, vegetables and sugarcane.

Commercial farming is just the opposite to subsistence farming. In this case,most of the produce is sold in the market for earning money. In this system, farmers use inputs like irrigation, chemical fertilizers, insecticides, pesticides and High Yielding Varieties of seeds etc. Some of the major commercial crops grown in different parts of India are cotton, jute, sugarcane, groundnut etc. Rice farming in Harayana is mainly for commercial purpose as people of this area are pre- dominantly wheat eaters. However in East and North-Eastern states of India, rice cultivation would be largely of subsistence type.

2.Intensive and Extensive Farming:

The basic difference between these two types of farming is the amount of production per unit of land. In comparison with temperate areas of USA, Canada, and former USSR, India does not practise extensive cultivation. When we use large patch of land for cultivation then we call it extensive farming. Here, total production may be high due to larger area but per unit are production is low . Intensive Farming records high production per unit of land. Best example of intensive cultivation is in Japan where availability of land for cultivation is very limited. Similar kind of situation can be observed in the state of Kerala in India.

3. Plantation Farming:

It is an estate where a single cash crop is grown for sale. This type of agriculture involves growing and processing of a single cash crop purely meant for sale. Tea, coffee, rubber, banana and spices are all examples of plantation crops. Most of these crops were introduced in India by the Britishers in the 19th Century.

4.Mixed Farming:

It is a situation in which both raising crops and rearing animals are carried on simultaneously. Here farmers engaged in mixed farming are economically better of than others. All classifications are based on nature and purpose of farming. It may overlap. For example: Banana is a plantation type of farming. It can also be classified as commerical farming.

o	Types of Crops	Meaning	Major Crops
1	Food grains	Crops that are used for human consumption	Rice, Wheat, Maize, Millets, Pulses and Oil seeds
2	Commercial Crops	Crops which are grown for sale either in raw form or in semi-processed form	Cotton, Jute, Sugarcane, Tobacco and Oilseeds
3	Plantation Crops	Crops which are grown on Plantations covering large estates	Tea, Coffee, Coconut and Rubber
4	Horticulture	Sections of agriculture in which Fruits and Vegetables are grown	Fruits and Vegetables

Indian Agriculture

- Agriculture Sector is changing the socio-economic environments of the population due to liberalization and globalization

- About 75% people are living in rural areas and are still dependent on Agriculture. About 43% of India's geographical area is used for agricultural activity

- Agriculture continues to play a major role in Indian Economy

Indian Agriculture

- Provides about 65% of the livelihood
- Accounts for 27% of GDP
- Contributes 21% of Total Exports, and Supplies Raw materials to Industries
- Growth Rate in production - 5.7%
- Food grains production – 211.17 mt

India's position in world Agriculture

	Rank
• Total Area	Seventh
• Irrigated Area	First
• Population	Second
• Economically Active population	Second
• Total Cereals	Third
• Wheat	Second
• Rice	Second
• Coarse grains	Fourth
• Total Pulses	First
• Oil Seeds	Second
• Fruits and Vegetables	Second
• Implements (Tractors)	Third
• Milk	First
• Live Stock (castles, Buffaloes)	First

Mile Stones in Agricultural Developm

- Green Revolution (1968)
- Ever-Green Revolution (1996)
- Blue Revolution (water, fish)
- White Revolution (Milk)
- Yellow Revolution (flower, edible)
- Bio-Technology Revolution

Development of Indian Agriculture : Basic Issues

- **Revitalization of Cooperative Institutions**
- **Improving Rural Credits**
- **Research, Education & Extension**
- **Human Resources Development**
- **Trade & Export Promotion**
- **Land Reforms**
- **Enabling Environment for higher Agricultural Growth**

The thrust areas:

- Diversification of Agriculture
- Inter-cropping
- Micro Management
- Water Management
- Organic Farming
- Agri-Clinics and Agri-business Centres
- Bio-Technology

Efforts on Policies, strategies and Frameworks

- National Agriculture Policy (2000)
- National Seeds policy (2002)
- Cooperative Policy
- Agricultural Price policy
- Agricultural Extension Framework (2001)

Technologies for Sustainable Agricultural Development

- Biotechnology
- Pre & post harvesting technology
- Energy saving technology
- Environment protection technology
- Information and Communication technology
- Internet/Intranet Technology

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