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CHAPTER ONE
INTRODUCTION TO AGRICULTURE

The term agriculture is derived from two Latin words
Ager:meaning field **Cultura**:field cultivation.

Therefore:
i) Agriculture is an art and science of crop and livestock production.

AGRICULTURE AS AN ART ENTAILS:
- **i)** Tilling of land.
- **ii)** Construction of farm structures.
- **iii)** Harvesting of crops.
- **iv)** Measuring of distance.
- **v)** Machine operations.
- **vi)** Feeding and handling of animals.
- **vii)** Marketing of agricultural produce.

AGRICULTURE AS A SCIENCE.
- **i) Crop pathology.** Study of crop diseases.
- **ii) Entomology. The study of insects and their control.**
- **iii) Agricultural engineering.** E.g. soil and water conservation and farm machinery.
- **iv) SOIL science.** Study of soils.

Production. All activities that increases quality and quantity. E.g. Land preparation, planting, fertiliser application.
In animal, production includes; selection and breeding, parasites and diseases control.

BRANCHES OF AGRICULTURE.
Major branches are:
1) Crop production.
2) Livestock production.
3) Soil science.
4) Agricultural economics.
5) Agricultural engineering.

1) CROP FARMING (ARABLE FARMING)
Arable farming is production of crops on cultivated land (monocropping/pure stands and mixed stands/intercropping)

a) Field crops.
Crops grown in fairly large area of land. Include annuals such as pulses and Cereals or perennial.

b) Horticultural crops.

These are perishable crops.
Entails:

i) **Floriculture.** Growing of flowers such as roses, carnations, lilies, chrysanthemums tuberose etc.
ii) **Olericulture.** Growing of vegetables such as cabbages, tomatoes, onions and French beans.
iii) **Pomology.** Growing of fruits such as Avocados, piers and citrus.

2) Livestock farming.

a) Pastoralism (mammalian livestock farming)

Pastoralism. Practice of rearing farm animals on pastures. Includes animals such as cattle, goats and sheep.

b) Fish farming/aquaculture.

Rearing of fish and other aquatic animals in fish ponds.

c) Apiculture.

Rearing of Bees in structures called beehives.

d) Poultry keeping.

Poultry are birds kept for production of eggs and meat.

3) Agricultural economics.

Branch of agriculture that deals with utilisation of scarce resources. Aims at maximising output while minimising cost.

4) Agricultural engineering.

Deals with use and maintenance of farm tools, machinery and structures.

Farming systems.

Organisation of the farm and all the enterprises in relationships to each other.

Extensive system.

Characteristics.

i) Requires large tract of land.
ii) Low capital investment.
iii) Low labour per unit area.
iv) Low yields per unit area.

Intensive system.

Characteristics.

5) Requires high capital and labour investment per unit area. High yields per unit area.

Large scale farming.

i) Involves use of large tracks of land.
ii) Requires heavy capital investment and skilled labour.
iii) Requires high level of management
iv) Operation cost per unit area of production is low.

Includes:
Plantation farming and ranching

a) Plantation farming.

Growing of one type of crop in a large area

b) Ranching.

Keeping of beef animals in marginal areas.

The livestock carrying capacity is low due to limited pastures.

Small scale farming.

Farming carried out on a small area of land less than five hectares.

Advantages.

i) Requires low capital investment.

ii) Possible where land is a limiting factor.

Disadvantages.

i) Uneconomical to mechanise due to small size.

ii) Low production.

iii) Difficult to specialise.

iv) Labour intensive.

Methods of farming.

A method of farming is an established way of carrying out farming activities. Includes.

i) Mixed farming.

ii) Nomadic pastoralism.

iii) Shifting cultivation.

iv) Organic farming.

v) Agroforestry.

Mixed farming.

Entails growing of crops and rearing of animals on the same farm.

Advantages.

i) Mutual benefit between crops and livestock.

ii) Acts as an insurance against total loss by the farmer.

iii) Maximum utilisation of resources.

Nomadic pastoralism.

Pastoralism. Practice of rearing livestock on pastures.

Nomadic. Practice of moving from one place to another.

Nomadic pastoralism. Moving with animals from one place to another in search of pastures and water.

Advantages.

i) Serves as backbone of beef industry in Kenya.

ii) Source of income to pastoral communities.

iii) Proper way of utilising arid and semi-arid areas.

Disadvantages.

i) Encourages spread of livestock pests and diseases due to communal watering points, grazing and spraying points.

ii) Tendency of increased soil erosion and land degradation.

iii) Difficult to control breeding and breeding diseases.
iv) Low production of both meat and milk and hides and skins due to energy losses.
v) Source of conflict and ethnic tension among the Nomadic communities for control of good pastures and water.

Shifting cultivation.

Method of cultivating a piece of land until the soil is exhausted and then the piece is abandoned /left fallow.

Advantages.

i) Land is allowed to rest and regain its fertility.
ii) No build- up of pests and diseases.
iii) Soil structure is restored.
iv) Cost of production is low since inorganic fertiliser and pesticides are not used.
v) Crop produce is chemical free.

Disadvantages.

i) Not applicable where land is a limiting factor.
ii) Farm planning and acquisition of credit is not possible.
iii) Lack of soil conservation measures.
iv) Not possible to grow perennial crops.
v) Low output per unit area due to poor farming methods.
vi) Where fire is used to clear land organic matter is lost.

Applicability.

i) Where land is communally owned.
ii) In large tracts of land. Where population is scarce.
iii) Where number of livestock per unit area is low.

Organic farming.

Farming method where crops are grown and livestock reared without use of agrochemicals.

Advantages.

i) Cheap and cost effective.
ii) Useful in improving soil structure.
iii) No environmental pollution.

Agroforestry.

Practice of integrating trees and crops on the same piece of land. Trees selected should have the following characteristics:

i) Able to grow fast.
ii) Deep rooted to minimise competition for nutrients.
iii) Should be preferably leguminous.

Examples.
Causurina equisetifolia
Grevillea robusta
Sesbania sesban
Cajanus cajan

Advantages.

i) Important sources of wood and timber.
ii) Maximum utilisation of land.
iii) Trees helps to control soil erosion.
iv) Some are used as livestock fodder.
v) Leguminous trees add nutrients into the soil thus improving soil fertility.

IMPORTANCE OF AGRICULTURE TO THE ECONOMY.

i) Source of food.
To meet the nutritional requirements and to enable man to engage in other activities.

ii) Employment.
Provides direct employment as farm labourers and indirectly e.g. working in agricultural based industries.

iii) Source of raw materials.
For industries e.g. cotton lint for textile industry.

iv)Source of market.
For industrial goods e.g. farm tools and equipment, pesticides etc.

v) Source of foreign exchange.
Through exporting agricultural produce, the country earns foreign exchange.

vi)Source of income.
Farmers as well as the government get revenue from the sale of agricultural produce and tax payment.

CHAPTER TWO
FACTORS INFLUENCING AGRICULTURE

These are:

i) Human factors.
ii) Biotic factors.
iii) Climatic factors.
iv) Edaphic factors.

Human factors.

Human characteristics that affect decision making and operations carried out.

Includes.

i) Level of education and technology.
ii) Human health/HIV-AIDS.
iii) Economy.
iv) Transport and communication.
v) Government policy.
vi) Cultural and religious beliefs.
vii) Market forces.

Human health/HIV-AIDS.

Effects of HIV-AIDS.

i) Shortage of farm labor.
ii) Loss of family support.
iii) Low living standards leading to despondency and hopelessness.
iv) Time wasted looking after the sick and money used to buy drugs instead of farm inputs.

Government policy.

Are government laws enacted to protect farmers, land and livestock.
Includes:

i) Food policy.
ii) Policies on control of livestock parasites and diseases.
iii) Policy on marketing of farm produce.

Policies by the government that helps improve agricultural production.

i) Heavy taxation of imports in order to protect local industries. This makes importation more expensive and discourage sale of products similar to those produced locally.
ii) Subsidizing the growing of locally produced commodities. This makes production cheap and affordable to most farmers. E.g. reducing tax on inputs to make them cheaper to buy and use.
iii) Quality control. This ensures production of high quality goods for both export and domestic market.

iv) Conservation of natural resources. To make them sustain agriculture. E.g. conservation of forests, water catchment areas, wildlife and soil.

v) Stepping up control of diseases and parasites that affect crops and livestock. Such measures includes: quarantine, licensing of quality products and vaccination of animals against infectious and contagious diseases.

Level of education and technology.

i) Low level of education results in farmers using poor methods of farming. They tend to rely on fate, superstitions and traditions.

ii) Knowledge in mathematics helps in measurements and calculations leading to accuracy in apply inputs and assessing results. It is necessary for proper accounting and analysis leading to proper decision making.

iii) Knowledge in science helps in observation, interpretation and solving problems.

What can be achieved with this high level of education and technology?

i) Proper method and time of doing things such as planting at the proper time and spacing.

ii) Use of the right type and amount of inputs.

iii) Applying the inputs at the right place. E.g. foliar fertilizers on the leaves.

iv) Making right decisions based on proper observation. It helps for example, in observing signs of disease and applying the right treatment or fertilizers.

High level of education leads to:

i) Accuracy in applying inputs and assessing results

ii) Helps in proper decision making and organization

iii) Better problem solution

iv) Better utilization of livestock feeds and fertilizers

v) Understanding of technical language used in agriculture

vi) Development of skills for operating machines and their maintenance

vii) Increase in efficiency and minimizes costs

Biotic factors.

Living organisms that affect agricultural production.

They include:

i) Pests.

ii) Pollinators.

iii) Parasites.

iv) Pathogens.

v) Predators.

vi) Nitrogen fixing bacteria.

Pests.

Destructive organisms. They cause the following.

i) Lowers the quality and quantity of agricultural produce.

ii) They transmit crop diseases. Pests with sucking mouthparts feed on sap and in the process they transmit crop diseases especially viral diseases.

iii) Some injure the plant parts which they feed on and as a result expose the plant to secondary infection. They may also lead to rotting of produce.

iv) They increases the cost of producing crops. This is because control measures have to be undertaken such as chemical control which is expensive.

Parasites.

Invertebrates which live in or on other living organisms. (Endoparasites and Ectoparasites.) They suck blood from the animals and irritate them by biting on their skin.

Decomposers.

Micro-organisms that act on plant and animal remains. They lead to decomposition thus adding organic matter to the soil.

Predators.

Animals that kill and feed on other animals. Predators that feed on pests are beneficial to farmers as they reduce pest populations.

Pathogens.

Micro-organisms that transmit diseases. They cause death of plants and livestock. They reduce both the quality and quantity of agricultural products. Include: bacteria, viruses and fungi.

Pollinators.

Can be insects or birds. They lead to cross pollination which helps in the production of new and improved varieties of crops. Include: bees, butterflies.

Nitrogen fixing bacteria.

Found in the nodules of leguminous crops roots. Convert nitrogen from air into nitrates. Their presence in soil make soil more fertile when leguminous crops are grown.

Climatic factors.

Include:

i) Rainfall.

ii) Temperature.

iii) Relative humidity.

iv) Wind.

v) Light.

Weather. Atmospheric conditions of a place at a given period of time.

Climate. Weather condition of a place observed and recorded for a period of 30-40 years.

Rainfall.

Water is required by the plants for the following reasons:

i) Acts as a solvent for plant nutrients.
ii) Cools the plant during transpiration.
iii) Raw material for photosynthesis.
iv) Makes plant turgid hence providing support.

Plant responses to lack of adequate water.

i) Closing stomata to reduce water loss.
ii) Hastens maturity.
iii) Some will roll their leaves.

Aspects of rainfall.

1) Rainfall reliability.

It is the dependency on the meteorological timing on the onset of the rains. It determines time for land preparation and planting.

2) Rainfall amount.

Quantity of rainfall that falls in a given area within a given year measured in millimeters
It determines the type of crops to grow and type of livestock reared in an area.

3) Rainfall distribution.

Refers to the number of wet months in a year. Influences the choice of crop varieties grown in an area. Annual rainfall indicates the amount of rainfall available during the year though it does not tell about how it is spread throughout the year.

4) Rainfall intensity.

Amount of rain that falls in an area within a period of one hour and is measured in MM per hour.
Rainfall of high intensity damage crops and causes soil erosion.

Temperature.

The hotness or coldness of a place measured in degrees Celsius or centigrade
Topography is the surface feature of an area and it affects the temperatures of a place.

Effects of temperatures on crop production.

Low temperatures.

i) Slows growth rate of crops as the process of photosynthesis is slowed.
ii) High incidences of disease infection to crops such as Elgon die back, CBD and hot and cold diseases of coffee.
iii) Quality of some crops such as tea and pyrethrum improves with the lowering of temperatures.

High temperatures.

i) Increases evaporation leading to wilting of crops.
ii) Increase rate of growth or hastens maturity of a crop.

iii) Improves the quality of some crops such as pineapples and oranges.

iv) Increases incidence of disease infection and pest attack in crops. For example, leaf lust in coffee and aphids in vegetables.

Ecological zone.	Range of altitude.	Livestock.	Crops.
High altitude. (high potential)	2100 m and above.	Exotic dairy breeds of cattle and wool sheep breeds. Exotic beef breeds.	Tea, pyrethrum and high altitude maize varieties.
Medium altitude. (High to medium potential.)	1500-2100m	Exotic dual-purpose breeds. (boran and sahiwal) Exotic dairy breeds such as Guernsey and jersey. Dairy goats.	Coffee, maize hybrids of medium altitude, bananas and beans.
Low altitude. (Low potential.)	900-1500m	Zebu cattle, meat goats.	Katumani maize, bananas, sorghum, pigeon peas, cassava.

Wind.

Refers to air in motion.

Effects of strong wind in agriculture.

i) Increasing the rate of evaporation of moisture from the soil.
ii) Causing lodging in cereals and damage to crops.
iii) Blowing away and bringing rain-bearing clouds.
iv) Acting as agent of seed dispersal.
v) Acting as agent of soil erosion.
vi) Increasing evaporation rate.
vii) Increasing the spreading of pests and diseases.
viii) Destroying farm structures.
ix) Areas with high humidity tend to be hotter but when wind takes away atmospheric water, a cooling effect occurs.

Relative humidity.

- ✓ It is the amount of water vapor held by air at a given temperature, compared to what it would hold when saturated. It affects the rate of evaporation and transpiration.
- ✓ Evaporation is the loss of water from the soil surface in form of water vapor while transpiration is the loss of water vapor through the leaf pores. At high relative humidity, the rate of evapotranspiration is low.

Light.

Light provides the energy required for photosynthesis.

Aspects of light.

1) Light intensity.

Strength with which light is harnessed by chlorophyll for the purpose of photosynthesis. Rate of photosynthesis increases with increase in light intensity. Low light intensity makes plants especially seedlings to become etiolated (thin and pale in colour).

Ways of increasing amount of light harnessed by crops.

- **i)** Pruning.
- **ii)** Thinning.
- **iii)** Weeding.
- **iv)** Use of a wider spacing.

2) Light duration.

Refers to the period during which light is available to plants per day.

Photo periodism. Plant response to light duration.

- **i) Short-day plants.** Requires less than 12 hours of day light to flower and seed. E.g. soya beans, rice and tobacco.
- **ii) Long-day plants.** Requires more than 12 hours of daylight to flower and seed. For example; some wheat varieties.
- **iii) Day-neutral plants.** Requires 12 hours day light to flower and seed. Include tropical plants like; coffee, maize and beans.

3) Light wavelength.

- **i)** Chlorophyll absorbs certain wavelength of light which are not present in artificial light unless incase of ultra-violet or infra-red.
- **ii)** Green houses or Glass houses can be used to control temperatures, relative humidity and light intensity and duration.

EDAPHIC FACTORS.

Soil is the natural material on the uppermost layer of the earth's crust which support plant growth. Consist of a mixture of weathered rock and decayed organic matter. Supports plant's life by providing anchorage, nutrients and water.

Soil formation.

- ✓ Soil is formed through weathering process. Weathering is the breakdown and alteration of the parent rock near the earth's surface.
- ✓ A series of complex changes occur and alter the form, colour, texture and composition of rocks.
- ✓ Weathering is a combination of disintegration (breakdown down process) and synthesis (building up process.) Weathering is brought about by physical, biological and chemical processes.

Soil forming factors.

i) Climate.
ii) Parent materials.
iii) Living organisms.
iv) Topography.
v) Time.

Physical agents of weathering.

These includes: wind, water, moving ice and temperatures.

i) Strong winds carry materials which hit against each other making surfaces of the materials break off into smaller fragments.
ii) When rocks or other materials are moved along the ground, they have a grinding effect.
iii) Moving ice also has a grinding effect.
iv) Rainfall of high intensity erodes rock surfaces.
v) In places of high altitude, the temperatures are low and when water gets into cracks, it freezes and become ice. This increases the volume of water by 9%. The increase in volume exerts pressure on the walls of the cracks in the rocks widening them and dislodging mineral grains from small fragments.
vi) In arid and semi-arid areas, temperatures are very high during the day. This makes the rocks to expand starting from the outside to the inside. At night, temperatures drop. This makes the rocks to cool and contract starting from the surface. This unequal expansion and contraction of the rocks causes the outside part of the rocks to flake off.
vii) This physical or mechanical weathering in time causes the disintegration of rocks without any chemical changes being involved.

Biological agents of weathering.

Living organisms play a very important role in soil formation.

i) When large animals such as elephants, buffaloes, cattle, horses, camel and man move, they exert pressure on the rocks causing the small fragments to disintegrate.
ii) Man's activities like mining, earth moving, cultivation and construction of buildings, railways and roads reduce the size of the rocks into smaller particles.
iii) Bacteria and fungi initiate the breakdown of plant tissue on the surface and within the soil. Organisms such as ants' termites are also important in tropical soil formation.
iv) Termites bring to the surface large quantities of fine materials. This promotes weathering as lower materials become aerated.
v) Earthworms feed on plant tissues and their waste matter helps to cement soil particles.
vi) Roots of growing vegetation force their way into cracks on the rocks exerting pressure which eventually splits the rocks. When the plants die, the roots decay leaving gaps in rocks which are then occupied by water and air that forms acids that dissolve minerals from rocks and corrode rocks weakening them.
vii) Roots produce acids in the soil during respiration, which dissolves minerals from rocks.

Chemical weathering.

i) It is the actual decay or decomposition of rocks. Involves various chemical reactions which take place between rock minerals, water and certain atmospheric gases like oxygen and carbon(iv) oxide.

ii) The chief agent of chemical weathering is water.

iii) As rain water falls through the atmosphere, it dissolves some carbon iv oxide forming very weak carbonic acid. This acid reacts with the mineral particles of the rocks particularly calcium carbonate causing decomposition.

Rain water + carbon (iv) oxide= weak carbonic acid.

$H_2O + CO_2 \longrightarrow H_2CO_3$

Weak carbonic acid + limestone $\longrightarrow$ calcium bicarbonate.

$H_2CO_3 + CaCO_3 \longrightarrow Ca(HCO_3)_2$

iv) The calcium bicarbonate formed is soluble in water and this process dissolves the rocks.

v) Oxygen reacts with many elements such as iron from olivine rocks forming ferrous and ferric oxides that produces red soils.

Factors influencing soil formation.

Parent rock material.

i) Influence physical properties and chemical constituents of the soil.

ii) Texture of the soil affects rates of soil formation. Freely drained parent materials form soils faster than dense impermeable parent materials.

iii) Mineral composition of the soil depends on the nature of the parent material. Rocks containing calcite, feldspar and Ferro magnesium minerals are likely to produce deep heavy soils rich in plants nutrients.

iv) It influences the type of natural vegetation in an area.

Climate.

i) Rainfall provides water which is an important reactant in all forms of weathering. The precipitation: evaporation ration is important. If precipitation exceeds evaporation, there will be loss of ions in drainage water. If surface evaporation exceeds precipitation, there will be accumulation of salts either on the surface or within the soil profile.

ii) High temperatures speed up the rate of chemical reactions. In cold regions, chemical reactions are slow and activity of micro-organisms is also slow limiting soil formation.

iii) Wind acts as a transport agent and carries weathered materials from one place to another. Where a lot of weathered materials are deposited, soils are deep and where wind carries away the top soil, the soil remain shallow or bare rock is left.

iv) Dry areas have soils with carbonate accumulation in the profile.

Topography.

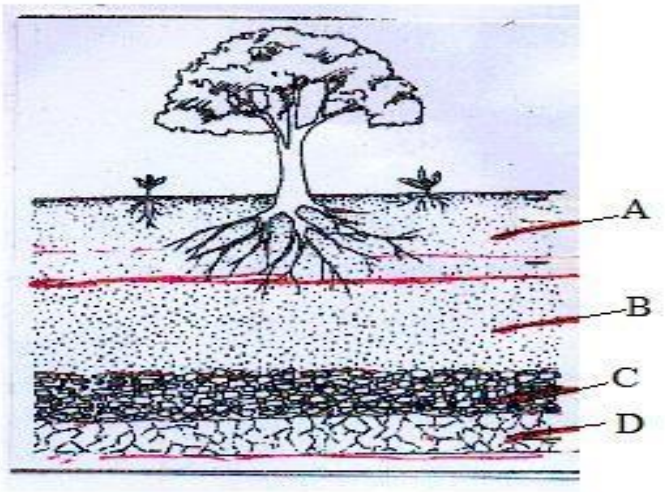
It is the shape of land in relation to the underlying rock of the earth's surface.

i) Factors such as elevation, slope and degree of exposure or shelter may influence the degree of soil erosion.

ii) Slope affects the depth of the soil and kind of vegetation growing in an area. Soils found in flat land and low lying areas tend to be more fertile than those on higher slopes.
iii) On steep slopes there is soil erosion that leads to shallow soils.
iv) In flatter areas, there are deeper soils that are richer in minerals due to deposition. The soils tend to be darker in colour and well drained.

Time.
i) Where soil forming process have taken place over a long period, deep mature soils can be found.
ii) Where erosion has been severe there is a tendency of soil to remain shallow and youthful with a poorly differentiated profile.
iii) In flatter areas, soil erosion is less and this makes the time factor have a greater effect on the soil, giving rise to mature soils. If parent material is not easily weathered, it may take a long time for soil to grow to maturity and develop in depth.

SOIL PROFILE.
Vertical arrangement of various soil layers/horizon.



1) Superficial layer.
Thin layer consisting of dry decaying and decayed origin matter covering the soil's surface.

2) Top soil (Horizon A) Uppermost soil layer.
i) Darker in colour than other layers due to its high humus content.
ii) It is well aerated and contains active micro-organisms.
iii) Well drained and contains most of the plant nutrients.

4) Sub-soil. (Horizon B)
i) More compact and less aerated than the top soil.
ii) Hardpan which is an impervious layer may be found in this region. Hard pan impedes drainage and root penetration.
iii) Downward movement of clay colloids are deposited in this region hence called layer of accumulation.

5) Substratum/weathered rock. (Horizon C)

Made of partly weathered rock with no humus.

i) It is hard and impervious to water.

ii) Roots of large trees may reach this layer to draw water in dry season.

6) Parent rock. (Horizon D)

i) Called the bedrock.

ii) Soil is formed from this rock.

iii) Ponds of water are also found here.

iv) A transitional zone is found between any two bordering soil layers which reflects properties of adjoin horizons.

Differences between soil formed in situ and soil formed in deposition

i) Soil formed in situ.	**i)** Soil formed in deposition.
ii) Shallower.	**iii)** Deeper.
iv) Less rich in plant nutrients.	**v)** Picher in plant nutrients.
vi) Easily eroded.	**vii)** Not easily eroded.
viii) Has the colour and characteristics of the parent rock.	**ix)** Has the characteristics of where it came from.
x) Less silty.	**xi)** More silty.
xii) Has the same chemical composition as that of underlying parent rock.	**xiii)** Differs in chemical composition from the underlying parent rock.

Soil depth. Distance between top soil layer and the bottom soil layer in a soil profile.

i) Deep soils are suitable for crop growth since they contain more nutrients.

ii) Deep soils facilitate good drainage and aeration.

iii) Deep soils have larger surface area for root expansion.

iv) Loosely packed sub-soil allows easy penetration of roots, drainage and aeration. This ensures soil erosion does not take place.

v) Nature and composition of bedrock influences mineral components of the whole soil.

SOIL CONSTITUENTS

Soil is made up of the following:

i) Mineral matter

ii) Soil water

iii) Soil air

iv) Organic matter

v) Living organisms

1. Mineral matter

These are inorganic compounds formed from the weathering of rocks. They differ in size ranging from clay to gravel. They include:

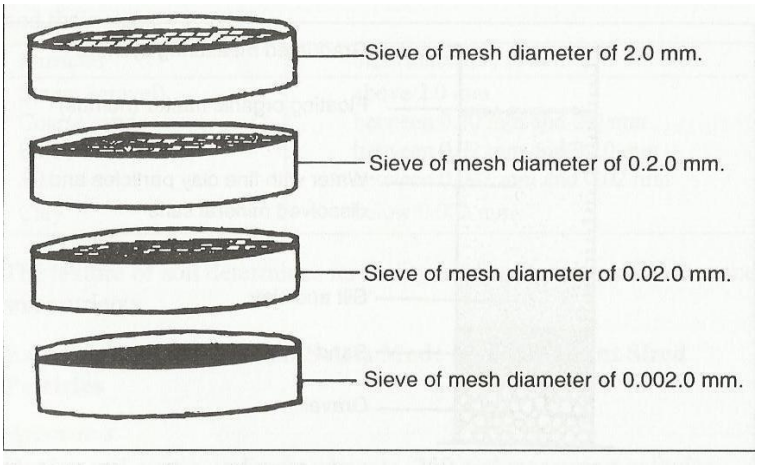
i) Clay
ii) Silt
iii) Sand
iv) Gravel

Influence of mineral particles on crop production

They make the main frame work of the soil
They hold plant roots firmly together

How to determine the mechanical composition of the soil

Using various sieves of different diameter



2. Soil water

Soil has water which comes from rainfall and also from irrigation in dry lands

Forms of soil water

i) Superfluous water
ii) Capillary water
iii) Hygroscopic water

Superfluous water

i) This is water which is held by gravity. It is also called gravity water.
ii) Its easily lost because its loosely held by soil particles
iii) Its readily available to plants but not useful because too much of it limits aeration

Capillary water

i) This is water occupying the micro pores. It is held by soil particles
ii) It's the water available to plants. It is also referred to as available water

Hygroscopic water

This is water which forms a thin film around the particles. It is not available to plants

Functions of water to plants

i) Soil water maintains the life of plants

ii) It is used as a raw material for protein for diffusion of mineral salts and oxygen into the root hairs and the mineral salts dissolved in water are conducted upwards to the leaves.

iii) It is also acts as a solvent for the diffusion of other substances from one part of plant to another

iv) It makes protoplasm and cell sap of the growing plants

v) It keeps the cell turgid and thus supports plant

vi) Also cools the leaves of the plant during transpiration

Experiment 1 to find the percentage of soil water content

Apparatus: - dish, stirring, weighing balance, soil sample and heater or oven

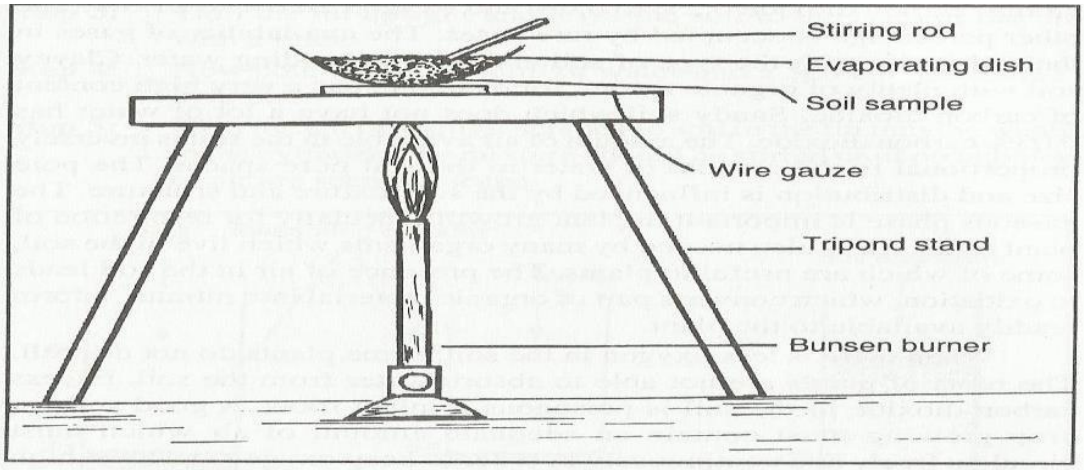


Fig 2.8: To find the percentage of total water content of soil

Mass of fresh soil only = (x+y−x) = yg

Mass of dish + dried soil = (x+z)g.

Mass of dried soil only = (x+z−x) = zg

Mass of water driven off = (y−z)g

Percentage of water by mass

$$= \frac{\text{Mass of moisture}}{\text{Mass of fresh soil}} \times 100 = \frac{(y-z)}{y} \times 100$$

Procedure:

i) Measure the mass of the dish

ii) Pour soil in the dish and weigh

iii) Half fill the dish with water

iv) Heat up to about 105^{o}c

v) Cool the sol with a desiccator then reweigh and repeat the process until you get a constant mass

3. Soil air

The spaces between the soil particles are filled with air. These include

Oxygen ---------- 20.6

Carbon dioxide ------- 0.6

Nitrogen ---------- 78.6

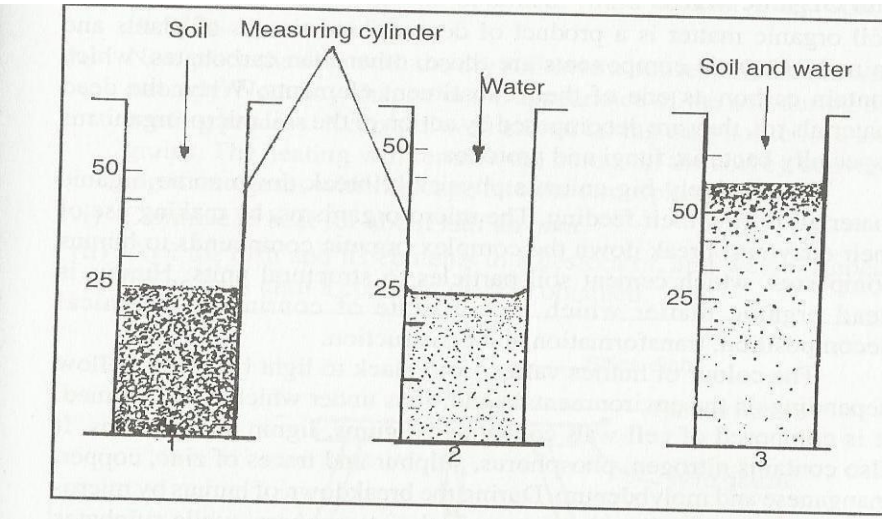
Other rare gases.

The amount of air available in the soil is inversely proportional to the amount of water in the soil pore spaces.
Oxygen present in the air is essential for the respiration of roots and other living organisms in the soil
Nitrogen in the soil is converted into nitrates by the nitrogen fixing bacteria
Air is also needed by the micro- organisms living in the soil
Excess carbon dioxide in the soil is poisonous to plants

Experiment 2: To find the percentage of air by volume in a soil

Apparatus

i) Small tin
ii) Graduated cylinder
iii) Knife and stirring rod



Procedure

i) Turn the empty tin upside down and press firmly into the ground until the tin is completely filled with soil
ii) Turn the tin upright and level the soil to the brim of the tin with a ruler
iii) Pour 250cm^3 of water into a cylinder and scrap off soil into the water until no bubbles comes out
iv) Record the final volume of soil and cylinder

4. Soil organic matter

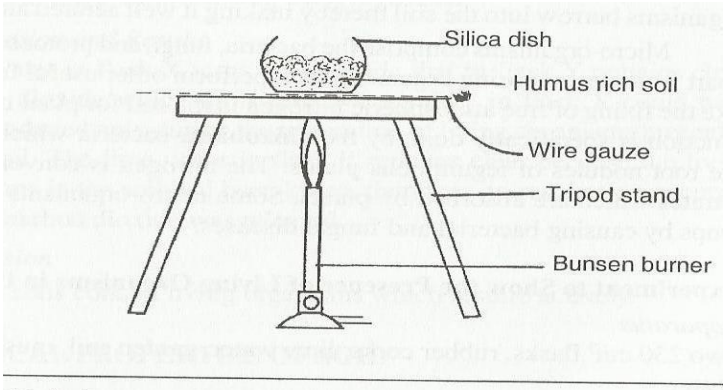
i) Organic matter in the soil is the remains of the dead plants and animals plus their waste products
ii) Humus is the decayed organic matter

Importance of organic matter

i) Decomposes to release nutrients to plants
ii) Makes the soil lighter to cultivate
iii) Also improves the soil structure

Experiment 3: To find the % of humus content in the soil

i) Apparatus
ii) Dish
iii) Garden soil
iv) Tripod stand
v) Wire gauze
vi) Bunsen burner



To find percentage of humus content

Procedure

i) Weigh the empty dish
ii) Put the garden in the dish and reweigh
iii) Place in an oven at about $105^{o}c$
iv) Cool in a desiccator and reweigh
v) Repeat the process several times until a constant weight is obtained
vi) Note the difference weight

5. Soil living organisms

There are two types of living organisms in the soil namely:

i) Macro organisms
ii) Micro organisms

Macro organisms are large organisms found in the soil e.g. rodents, earthworms, ants, termites, plant roots etc.

Microorganisms are tiny organisms which can only be seen with the help of a microscope they include bacteria, fungi, protozoa etc.

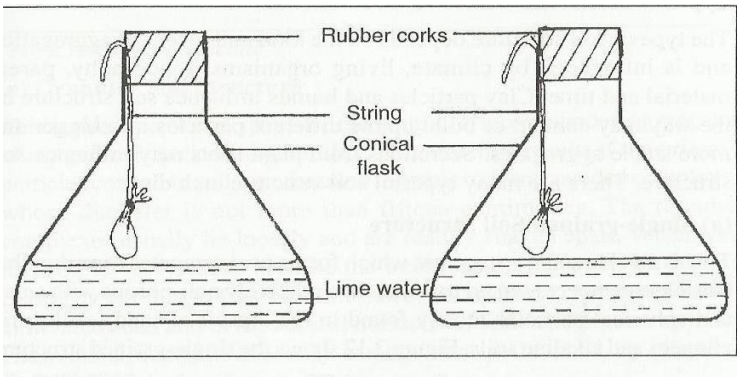
Importance of soil living organisms

i) They barrow in the soil and aerate the soil and improve drainage
ii) They help in the decomposition of organic matter
iii) Some also fix nitrogen in the soil e.g. the nitrogen fixing bacteria

Experiment 4: To show the presence of living organisms in a soil sample

Apparatus

i) 2 flasks
ii) Rubber cork
iii) Muslin bag
iv) Heater
v) Lime water
vi) Garden soil



Procedure

i) Put a handful of garden soil in two muslin bags labeled A and B
ii) Heat the soil in muslin bag B strongly to kill the micro organisms
iii) Suspend the two bags in the flasks also labeled A and B, the flasks should contain lime water
iv) Leave the apparatus for 4hrs

Observation

i) Lime water in flask A turns milky
ii) Lime water in flask B remains clear

Conclusion

i) Lime water in flask A turns milky because of the presence of carbon dioxide produced during respiration. Carbon dioxide turns lime water milky
ii) Lime water in flask B remained clear since the living organisms were killed during heating so no respiration took place

Physical properties of soil

These include:

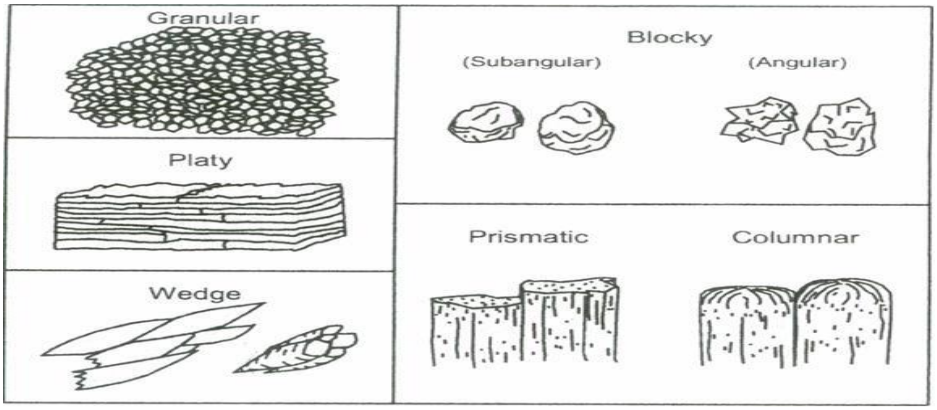
i) Soil structure **ii)** Soil texture **iii)** Soil colour

1. Soil structure

This is the way in which the individual soil particles are arranged

Types of soil structure

(a) Single grained structure
(b) Crumby structure
(c) Granular structure
(d) Platy structure
(e) Blocky structure



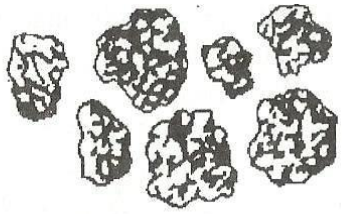
(a) Single grained structure

In this structure, the particles are not cemented together. They exist as individual grain. They form no aggregates and are non-porous.

They are mostly found in top soils of sandy soils and in arid climate and in alkaline soils

(b) Crumby structure

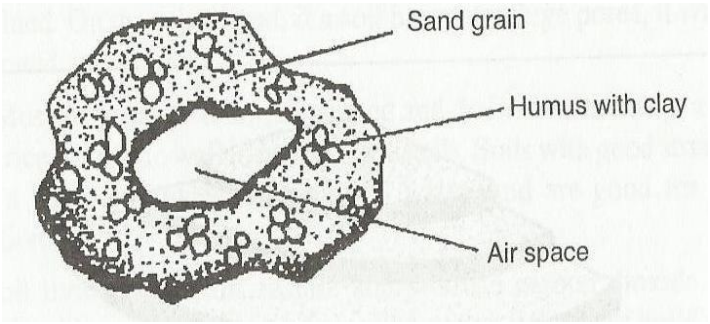
This type consists of small, soft porous aggregates of irregular shapes. They are not closely fitted together



Crumb type

(c)Granular structure

This is made of friable rounded aggregates of irregular shapes called granules. It is formed when particles coagulate and are cemented together to form rounded aggregates whose diameter is not more than 15cm



When wet it becomes porous since the spaces are not readily closed by swelling. The structure is found in top horizon in cultivated soils and in the sub- soil under grass. The structure is not porous and is usually affected by tillage.

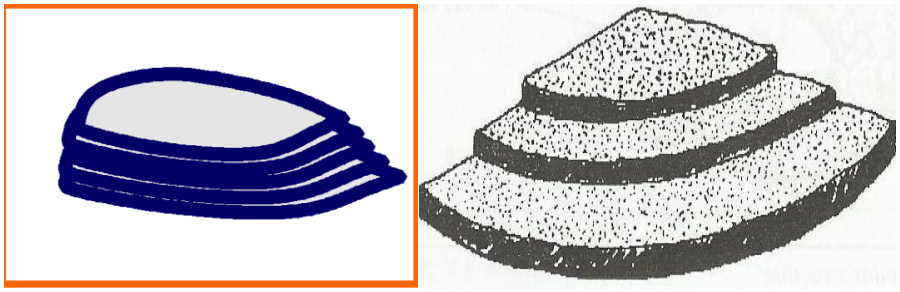
(d) Prismatic structure

This is where the structure aggregates are arranged vertically. The primary particles are vertically oriented forming distinct columns which vary in length depending on the type of soil.

The structure is found in sub soil of arid and semi arid soils

N/B: If the tops are rounded, they are called **columnar.** But if the tops have clear cut edges, the it is called **Prismatic**

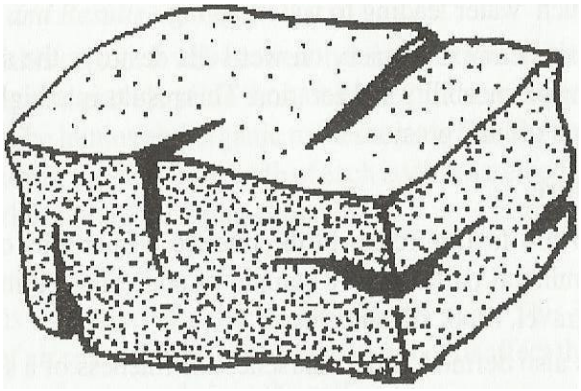
(e)Platy soil structure



In this structure, the aggregates are arranged on top of one another on thin horizontal plates. The plates overlaps and impair permeability and hence drainage and root penetration. The structure is found in top soils of clay soil and forested area.

(f) Blocky structure

Here the aggregates are in form of rectangular blocks. The aggregates easily fit together a long vertical edges



Influence of soil structure on crop production

- **i)** A loosely packed structure ensures good air circulation in the soil
- **ii)** Good structure also ensures proper water holding capacity
- **iii)** Good structure also gives proper root anchorage
- **iv)** Good structure also reduces then soils liability to erosion

<u>Factors that influence the soil structure</u>

a) Parent material

The physical and chemical properties of the parent rock will determine the type of structure being formed

b) Soil forming processes

Processes which lead to soil formation will determine the type of structure being formed

c) Climate

In areas where a lot of rainfall is followed by dry periods cracks tend to form giving rise to good structure which is well aerated

d) Organic matter

Presence of organic will stabilize the soil structure

e) Living organisms

Living organisms also help to decompose organic matter which intern improve structure

f) Cultivation

The nature of cultivation e.g. digging channels results in a better structure

g) Inorganic compounds

Presence of compounds like iron oxide have binding properties and help in the formation of granules

2. Soil texture

This refers to the relative proportion of various sizes of mineral particles in a soil.

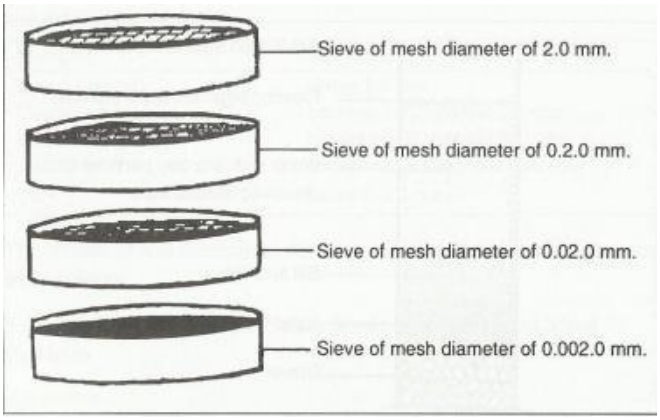
	Particles	Diameter
i)	Clay	0.002mm and below
ii)	Silt	0.002 ------ 0.02
iii)	Fine sand	0.02 ------- 0.2
iv)	Coarse sand	0.2 -------- 2mm
v)	Gravel	2 ---------- 20mm
vi)	Stone	20mm and above

Determination of soil texture Can be determined by:

- **i)** Mechanical analysis
- **ii)** Chemical analysis

Mechanical determination of soil texture

Apparatus



- **i)** Sieves of different diameter
- **ii)** Containers
- **iii)** Weighing balance

Procedure

- **i)** Put a known amount of soil sample in a container
- **ii)** Pass the soil through a sieve of the smallest diameter and shake
- **iii)** Weigh the soil that remains in the sieve
- **iv)** Repeat the process using sieves of different diameter until all the soil I passed through

Observation

After every sieving it will be observed that a certain amount of soil remains in the sieve

Conclusion

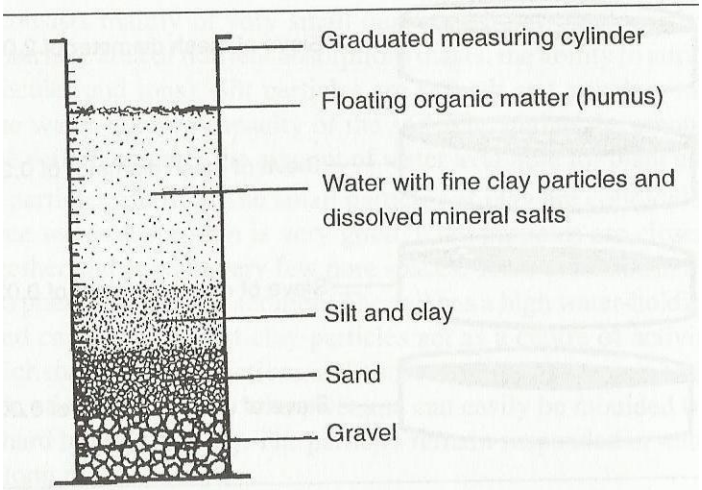
Soil is made up of different sized particles of different diameter

Experiment 6: to show that soil is made up of different sized particles

Apparatus

- **i)** Measuring cylinder
- **ii)** Sodium carbonate

Garden soil



Separation of soil particles

Procedure

i) Put some soil sample in a measuring cylinder
ii) Add about 4 times its volume of water with sodium carbonate to aid in dispersion of particles
iii) Cover the mouth of the cylinder with the hand and shake vigorously for about 2min.
iv) Place cylinder on the bench for about 1hr or more to allow the contents to settle down

Observation

i) At the end of the period, it will be seen that fractions have settled in layers
ii) The heavy, coarse gravels settle first, then followed in succession by sand, silt and clay
iii) The humus and organic matter remain floating in the water or on top of the clay

Conclusion

From the above observations, it can then be concluded that soil is a mixture of particles of different sizes.

Influence of soil texture on crop production

i) Coarse soils have poor water holding capacity
ii) Very fine textured soils also have poor aeration

Soil colour

i) Soil colour depends mainly on the mineral composition of the soil
ii) If the soil was made from a rock containing a lot of iron compounds, it tends to be brownish yellow, reddish or orange in colour
iii) Humus content also gives dark brown colour
iv) Soil colour influences temperature of the soil

Soil classification

Soil can be classified based on the following

i) Soil structure
ii) Soil texture
iii) Soil colour
iv) Soil pH

According to structure, soils could be classified as granular, crumby, blocky, or platy soil structures
According to texture, a soil containing high proportion of sand particles is called **sandy soils**, if it contains high amount of clay then it is called **clay soils**
In terms of colour, soils could be either dark coloured soils or light coloured soils

Types of soils

i) Sandy soils
ii) Silty soils
iii) Clay soils
iv) Clay loams
v) Loamy soils

1. Sandy soils

i) They have bigger particles
ii) Contains 50 - 80% sand, and 20 -50% silt and clay
iii) Organic matter content is 0.1 - 3%
iv) Are well drained
v) Are more prone to soil erosion have low water holding capacity
vi) They are slightly acidic
vii) Easy to cultivate but less fertile

How to improve sandy sols

i) Add organic matter
ii) Addition of fertilizers

2. Silty loams

i) They contain 20 – 30% sand
ii) Also contains 70 – 30% clay
iii) Has 0.1 - 4% organic matter
iv) They are fine textured, well drained and have a good water holding capacity
v) They have moderately acidic pH.
vi) Moderately fertile and aerated

3. Clay loams

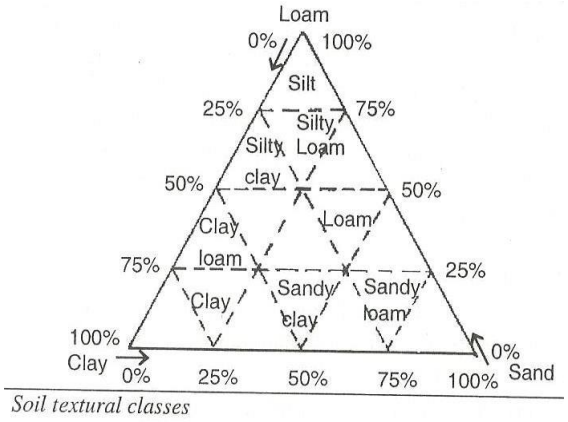
i) They contain 20 - 50% sand
ii) Clay and silt is 20 -60%
iii) Has organic matter content of 0.1 - 6%
iv) They are fine textured
v) Poorly drained and aerated
vi) Has capillarity and water retention
vii) They are rich in plant nutrients
viii) Are suitable for flood irrigation for rice growing
ix) This soil can be improved through drainage

4. Clayey soils

i) Have clay content of more than 40%
ii) Have high water holding capacity
iii) Have crystalline and platy structure
iv) Expand when wet
v) Crack when dry
vi) Get water logged easily
vii) Also suitable for flood irrigation
viii) Have high capillarity

5. Loamy soils

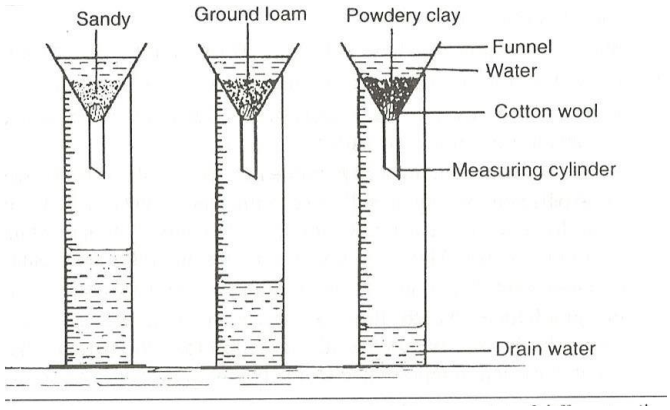
i) They contain 30 -50% sand, 50 -70% silt and clay and 0.4% organic matter
ii) Are moderately textured and drained
iii) Are slightly acidic
iv) Have good water holding capacity
v) Can be improved by planting cover crops and adding organic manures



Soil textural classes

Experiment 7: To compare the porosity and water holding capacity of sand, loam and clay
Apparatus

i) Measuring cylinder
ii) Funnels
iii) Cotton wool
iv) Dry sand, loam and clay



Procedure

i) Place equal volumes of each soil in each funnel plugged with cotton wool
ii) Tap all the funnels persistently until all visible air spaces are filled up
iii) Stand each funnel in the open end of measuring cylinder and add 50cm^3 of water into each funnel
iv) Note the time taken for the first drop of water through into the cylinder

Observation

After some time, it will be seen that water level is high in sand than the rest

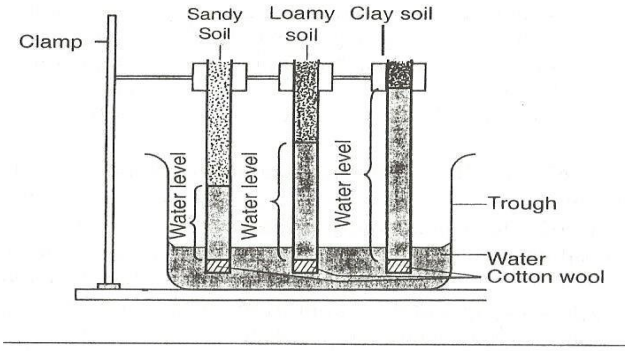
Conclusion

Sandy soil is more porous than the other 2
Clay soil has the highest water holding than the other 2

Experiment 8: To compare the capillarity of sand, loam and clay

Apparatus

i) 3 long cylinders
ii) Dry sand, clay and loam
iii) Water trough
iv) Clock
v) Ruler



To compare capillarity action in different soils

Procedure

i) Close the lower end of each tube with a plug of cotton
ii) Fill each tube with different soils
iii) Tap the end of each tube gently in the bench to tightly pack the soils
iv) Stand and clamp each tube with a clamp and put in an empty water trough
v) Poor water into the trough to a depth of 5cm
vi) Measure the height of water in each tube after 3 – 5min
vii) Take as many readings as much as possible
viii) Record the readings

Observations

i) Water will be seen to be rising up the tubes
ii) It rises very fast in sand and loam in the first 3 – 5min. but very slow in clay
iii) After 2hrs water level will be higher in loam than in clay soil and least in sand
iv) Water rise continues in clay soil but stops after some time in loam

Conclusions

i) Clay and loam have higher capillary action due to their fine pore spaces
ii) Sand has poor capillary action due to their large pore spaces
iii) Clay soil has the highest capillarity

Chemical properties of soil

1. Soil pH
2. Soil mineral content

1. Soil pH

i) This is the acidity or alkalinity of soil solution
ii) Acidity is determined by hydrogen ion concentration while alkalinity is determined by hydroxyl ion concentration

Influence of soil pH on crop production

i) Soil pH affects the availability of various nutrients e.g. low pH makes P, and molybdenum less available and high pH. makes Mn, K, Fe and zinc less available
ii) Very low pH affects the activities of microorganisms e.g. nitrogen fixing bacteria
iii) Different crop species require different pH ranges

Ways of modifying pH

i) Apply lime to raise the pH
ii) Apply basic fertilizers
iii) Apply sulphur to lower the pH
iv) Apply acidic fertilizers to lower the PH

CHAPTER THREE
FARM TOOLS AND EQUIPMENTS.

Introduction

i) Farm tools and equipment perform specific jobs in the farm.

ii) They make work easier and more efficient.

iii) They can be classified according to their uses as follows:

Garden Tools and Equipment

Tools	Uses
Panga	Cutting and shallow cultivation, making holes.
Jembe/hand hoe	Cultivation, digging, shallow planting holes and trenches.
Fork iembe	Cultivation, digging out roots, harvesting of root crops.
Rake	Collecting trash, breaking large clods, levelling, removing stfrom a seedbeones and spreading organic manure.
Spade	Scooping and carrying of soil, sand, concrete mixture and manure.
Spring balance	Measuring weight.
Trowel	Scooping seedlings during transplanting and .digging planting holes for seedlings.
Pruning hook	Bending tall branches when pruning.
Secateur	Cutting young stems and pruning branches.
10. Tape measure	Measuring distances.
11. Axe	Cutting big trees and roots and splitting logs of wood.
12. Soil auger	Making holes for fencing posts.
13. mattock	Digging hard soils
14. sprinklers	Overhead irrigation.
15. Watering can	Watering plants in nursery bed.
16. Wheel barrow	Transportation of soil, fertilizers, farm produce, tools and
17. Levelling board	For levelling a nursery bed. equipment.
18. Pruning saw	Cutting old wood stems and pruning big branches.
19. Hose pipe	For conveying water from a tap to where it is need.
20. Knap sack sprayer	Applying agro-chemical by spraying.
21. Garden shear	Trimming hedges.
22. Pruning knife	Removal of small shoots.
23. Meter ruler	Measuring distances.
24. Garden fork	Shallow digging.

Livestock production tools and equipments.

Tools	Uses
Drenching gun	Administering liquid drugs to animals orally.
Bolus gun/dosing	Administering solid drugs or tablets to animals orally.
gun Wool Shears	Cutting off wool from sheep.
Hypodermic syringe	Administering drugs by injection for example in vaccination.
Stirrup (bucket)	Application of acaricide by hand spraying.
pump Thermometer	Taking body temperatures of farm animals.
Burdizzo	Used in bloodless method of castration.
Halter	Rope designed to restrain the animal.
Trimming knife	Cutting short the overgrown hooves.
Elastrator	Stretching rubber ring during castration, dehorning and docking of lambs.
Iron dehorner	Applies heat on the horn bud to prevent growth of horns.
Nose ring	Fixed into the nose of a bull to restrain it.
Strip cup	Detecting mastitis in milk products.
Trocar and cannula	Relieving a bloated animal of gases particularly ruminants.
Hard broom	For scrubbing the floor.
Ear notcher	Making ear notches in livestock.
Bucket	For holding milk during milking.
Milk chum	For holding milk after milking.
Milk strainer/sieve	Removing foreign particles from milk for example hairs and sediments.
Rope	Tying or tethering animals.
Milking stool	Used by the milker to sit on while milking.
Weighing balance	Weighing milk after milking.
Teeth clipper	Removal of canine teeth of piglets soon after birth.
Chaff cutter	Cutting fodder into small bits.
Dehorning wire	Cutting grown horns.

Workshop Tools and Equipment

Tools	Uses
Spanner	Tightening and loosening nuts and bolts.
Pliers	Cutting small wires and thin metal and gripping
Files	firSharpening toolsmly. , smoothening or shaping edges of
Rasps	metalsSmoothen, ing and shaping of wooden
Chisels (wood)	Making grooves in Structures.
Cold chisel	Wood Cutting and shaping
Screw drivers	[l]Driving screws in or out of wood or metal·
Saws Cross cut saw	Cutting across the grain of wood.
Rip saw	Cutting along the grain of wood.
Hack saw Bow saw	Cutting metals.
Tenon back saw	Cutting branches of trees
Coping saw	Cutting Joints on wood and fine sawing.
Compass/keyhole saw	Cutting curves on thin wood. Cutting either along or across the grain of wood Esp Whenecially cutting key holes.
Tin snip	Cutting metal sheets.
Braces and bits.	Boring holes in wood.
Drill and bits	Boring holes in metal work and woodwork.
Hammer	
Claw hammer	Driving in, removing and straightening nails.
Ball pein	Driving in nails, rivets and straightening metal. Also uson cold chisel ed
Mallet	Hammering or hitting wood chisel.
Jack plane	Fine finishing of wood.
	Smoothening curved surfaces of wood such as handles of jembes, axes .
Measuring Metre ruler equipment	Measuring short length
Try square	-. Measuring length angles and to ascertain squareness.
Marking gauge	Marking parallel lines to the edge of wood.
Fencing pliers	Cutting wires, hammering staples when fencing.
Vice and clamps	Firmly holding pieces of w ork together.

INCOMPLETE NOTES

This Forms a Sample From The Original Notes

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For F1-F4 All Subjects Complete Notes

CHAPTER FOUR
CROP PRODUCTION 1
(LAND PREPARATION)

Land preparation.

i) All activities that makes land suitable for planting.

ii) Involves ploughing or digging, harrowing, ridging and rolling.

Importance of land preparation.

i. To kill weeds.

ii. To incorporate manure and other organic matter into the soil.

iii. To destroy different stages of crop pests such as eggs, larvae, pupae or adults by burying them, exposing them to heat of the sun and predators and starving them.

iv. To aerate the soil.

v. To encourage the penetration of roots in the soil.

vi. To make subsequent operations possible. Such operations include; planting, fertilizer application, rolling and ridging.

vii. To encourage water infiltration.

Operations in land preparation.

A. Land clearing.

i) It is the removal of vegetation cover from the surface before land is tilled.

ii) It is a method of land reclamation.

Conditions under which land clearing is necessary.

i. When opening up a virgin land.

ii. Where a stalk growing crop was previously planted.

iii. Where the interval between primary and secondary cultivation is long such that land has reverted to its original virgin state.

iv. Where land was left fallow for a long time.

Methods of land clearing.

i. Tree felling.

Involves cutting down of trees. Axes, pangas and small power saws are used in small scale. Bulldozers and root rakers are sued on large scale. Destumping/removal of stumps and disposal of trash follows.

ii. Burning.

The bush should be burned when the speed of wind is low to avoid possible spread of fire to other fields. It destroys a lot of organic matter, soil microorganisms and plant nutrients.

iii. Slashing.

Small bushes and grasses can be cleared by this method. A slasher or a panga is used in small scale. For large scale a mower is used.

iv. Use of herbicides.

These chemicals kills weeds faster and more easily.

B. Primary cultivation.

i) It is the initial opening of the land either after clearing the bush or following a previous crop.
ii) Hand digging is done using jembe or fork jembe. In large scale, moldboard and disc plough are sued.
iii) Primary cultivation is done well before the onset of rains to give time for all operations to be done in good time.

Importance of primary cultivation.

i. To remove weeds.
ii. To bury organic matter for easy decomposition.
iii. To facilitate water infiltration and aeration.
iv. To destroy soil-borne pests by exposing them to predators and sun.
v. To make planting easy.

Ways in which primary cultivation is achieved.

i. Hand digging.

Use of simple hand tools such as jembes, mattocks and fork-jembes to cut and turn the soil slices.

ii. Mechanical cultivation.

Use of tractor-mounted implements such as moldboard and disc ploughs. Subsoilers and rippers to break hardpans.

iii. Use of ox-plough.

It is faster and more efficient than hand digging. Common where the terrain is fairly flat.

Aspects to observe in primary cultivation.

1) Time of cultivation.

i) Land should be prepared well before the onset of rains to give weeds and other vegetation enough time to dry up and decompose.
ii) Early cultivation also allows carbon (iv) oxide and other gases to diffuse out of the soil.
iii) It also gives enough time for other subsequent operations to be done thus ensuring early planting.

2) Depth of cultivation.

Factors determining depth of cultivation.

i. Type of crop to be planted.

Deep-rooted crops requires a soil that has been cultivated deeply. It facilitates esay root penetration.

ii. The implements available.

Some cannot cut soil beyond a certain depth. Such implements can be sharpened or weight added on them to make them plough deeper.

iii. The type of soil.

Heavy soils are hard particularly when dry. Simple hand tools will dig shallowly on such hard soils.

3) Choice of correct implements.

Determined by:

i. The condition of the land.

- ✓ If land has a lot of stones and stumps, it si advisable to choose a disc plough which does not easily break on such land.
- ✓ A jembe cannot work efficiently on a land which has a lot of couch grass as it does not pull out all the rhizomes. In such a case a fork-jembe is more efficient.

ii. The type of tilth required.

A very fine tilth requires the use of different ty.es of implements.

iii. The depth of cultivation.

- ✓ Heavy implements are necessary when deep cultivation is needed. Light implements are required when shallow cultivation is required.
- ✓ Cultivate the field during the dry season when the soils are friable.
- ✓ Very dry soils are difficult to penetrate with simple implements.
- ✓ Very wet soils may lead to development of hardpans.

CHAPTER FIVE
WATER SUPPLY, IRRIGATION AND DRAINAGE

WATER SUPPLY.

The hydrological cycle.

The circulation of water from the earth's surface to the atmosphere and back.

Sources of water.

Includes.

i) Surfaces water sources.
ii) Ground water sources.
iii) Rain.

i) Surface water sources.

Includes:

Rivers, streams, lakes and dams.

i. Rivers, streams and dams.

Rivers and streams originate from water catchment areas such as mountains, hills and forests.
To facilitate collecting of this water, weirs and dams are constructed to raise the water levels.

Weir.

Barrier constructed across the river to raise the water level and still allow the water to flow over it.

ii. Dam.

Barrier constructed across a river or a dry valley to hold water and raise its level to form a reservoir or a lake. However a dam has a spillway provision to allow excess water to flow away.

iii.Lakes.

These are huge collections of water on land depressions. Some lakes are salty and cannot be used for farming.

Underground water sources.

Includes.

Springs, wells and boreholes.

i. Springs.

Water comes out of the ground as a result of an impervious layer meeting the ground surface.
Later it collects into a stream. It should be fenced around to prevent contamination by animals. Spring water is less contaminated than rivers or lake water.

ii. Wells.

These are holes dug in the ground until the water table is reached. Wells should be dug during the dry season when the water table is very low. A reinforced concrete slab with a lockable lid should be constructed to prevent accidents, contamination and wearing of the topsides of the well.

iii.Boreholes.
These are deep holes drilled or sunk into the ground by the use of drilling machine sunk up to the parent rock. Special pumps are used to lift water out of the hole.
iv)Rain water.
Rain water is collected from rooftops and stored in tanks during the rainy season. Ponds can be dug to collect the runoff. Rainwater is the purest water compared to water from other sources.

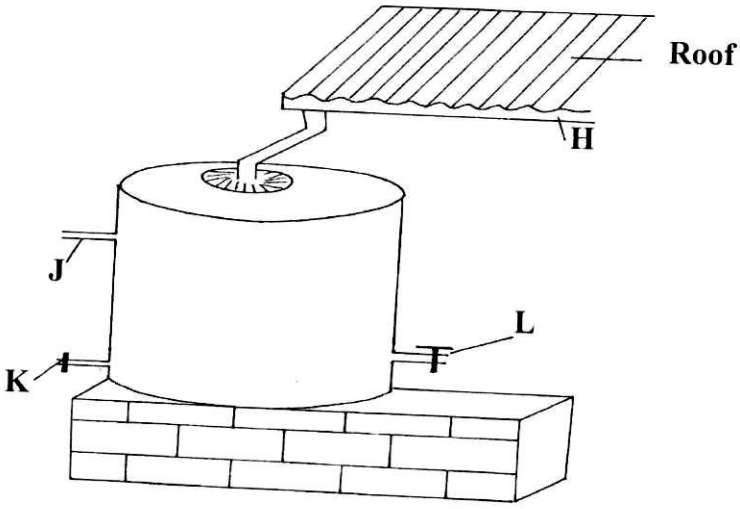
WATER COLLECTION AND STORAGE.

Dams.

i) They are constructed to collect and store water. The bottom part of the area behind the dam should have an impervious layer such as clay or rock to prevent water seepage.
ii) The embankment should be free from trees and bushes to prevent the roots from damaging it.
iii) Grass should be planted on the embankment to prevent soil erosion.

Weirs.
They are used to raise the water level in a river to facilitate pumping or flow by gravity.

Water tanks.
Made of concrete, stone, metal sheets, plastic or rubber.
They store water from rain or that which has been pumped. Tanks should be covered to prevent contamination from dust. Stone and concrete tanks should be reinforced with wire mesh or barbed wire during construction so as to resist water pressure.



Drums may be sued to store water but care should be taken to establish what these drums contained initially to avoid possible poisoning.

Pumps and pumping of water.
Pumping is the lifting of water from one point to another by use of mechanical force.

Water pumps.

i. Centrifugal/rotardynamic pumps.

These have metal discs with blades that rotate at high speed. Water is driven out by a centrifugal force to the outlet. They can pump large quantities of water. They are driven by petrol or diesel engine.

ii. Piston/reciprocating pumps.

Have pistons that move back and forth, thus pushing water through the pipes.
They do not pump a lot of water. Most are petrol/diesel driven or hand operated.

iii. Semi-rotary pumps.

Are used to pump water from wells by hands. They are manually operated and pump little amount of water mostly for domestic purposes.

iv. Hydram.

They are operated by the force of flowing water. The higher the speed of water, the greater the pressure created in the pump.
The limitation is that they cannot pump stationary water.
However, they pump water to considerable heights.

Conveyance of water.

This is the process of moving water from one point, mostly the source or point of storage, to where it will be used or stored.

Methods of conveying water.

- **i)** Piping.
- **ii)** Use of containers.
- **iii)** Use of canals.

Type and choice of pipes.

a) Metal pipes.

There are two types of metal pipes.

i. Galvanized iron pipes.

Are heavy and suitable for permanent installations.

ii. Aluminum pipes.

Are light and are used in irrigation systems. Metal pipes are expensive but durable.

b) Plastic pipes.

They are inexpensive and easy to install compared to metal pipes.
They are durable when properly installed.

Limitations of plastic pipes.

- **a)** They can burst under high pressure.
- **b)** They become brittle when exposed to the sun.
- **c)** They can be gnawed by rodents such as moles.

c) Hose pipes.

They are two types of hose pipes. Plastic and rubber hose pipes.
Rubber hose pipes are more expensive but are more durable.

d) Use of containers.

Water is drawn and put in containers such as drums, jerry cans, pots, gourds and buckets which are carried by animals, bicycles and human.

e) Use of canals.

Water is conveyed from a high point to a lower along a gradual slope to avoid soil erosion. Such water is used for livestock and irrigation.

Water treatment.

Process of making it safe for use in the farm.

Importance of treating water.

i. To kill diseases causing micro-organisms such as cholera and typhoid bacteria that thrive in dirty water.

ii. To remove chemical impurities such as excess fluoride which may be harmful to human beings.

iii. To remove smells and bad taste. Smells and bad taste in water make it unfit for human consumption.

iv. To remove sediments of solid particles such as soil, sand and sticks. This makes water clear.

CHAPTER SIX
SOIL FERTILITY: ORGANIC MANURES

Soil fertility.
The ability of the soil to provide crops with the required nutrients in proper proportions and form for high production.

Characteristics of fertile soils.

i. Good depth.
Deep soils give plant roots greater volume to obtain plant nutrients and provide strong anchorage.

ii. Proper drainage.
A well-drained soil is properly aerated promoting healthy root development. They allow root respiration and reduce the buildup of carbon (iv) oxide to toxic levels.

iii. Good water holding capacity.
This ensures that enough water is retained for plant use.

iv. Adequate nutrient supply.
Should supply the nutrients needed by plants in the correct amounts and in a form that is available to the crops.

v. Correct soil pH.
Different crops have different soil pH requirements. Certain plant minerals are only available at a specific soil pH.

vi. Free from excessive infestation of soil borne pests and diseases.

HOW SOIL LOSES FERTILITY.

i. Leaching.
As water infiltrate into the soil it dissolves soluble minerals. The dissolved minerals are carried to lower horizons beyond the reach of many plant roots. A soil with many nutrients that have been leached is infertile.

ii. Soil erosion.
It is the carrying away of the top fertile soil. Leads to loss of good soil and plant nutrients rendering soil infertile.

iii.Monocropping.
- ✓ It is growing one type of crop on a piece of land over a long time (monoculture). The crop uses only those nutrients it require while other nutrients remain unused.
- ✓ This leads to exhaustion of some particular nutrients.
- ✓ The crop grown utilizes nutrients from a certain zone thus soil in that zone become infertile as far as that crop is concerned.
- ✓ There is build-up of pests and diseases if one crop is grown continuously.

iv. Continuous cropping.

Harvested crops remove large amounts of nutrients from the soil.

The nutrients removed from the soil are taken away making soil deficient in these plant nutrients.

v. Change in soil pH.

Changes in soil pH affects the activity of soil micro-organisms as well as the availability of soil nutrients.

vi. Burning of vegetation cover.

- ✓ When vegetation is burnt, organic matter is destroyed leading to the destruction of soil structure.
- ✓ Accumulation of ash formed after burning cause nutrient imbalance which may lead to unavailability of some nutrients.
- ✓ Micro-organisms are also destroyed thereby interfering with microbial activities such as nitrogen fixation and decomposition or organic matter.
- ✓ The soil is also left exposed to the agents of soil erosion.

vii. Accumulation of salts.

- ✓ Soil water contains dissolved mineral salts which comes from parent rock. Other salts comes from decomposition of organic matter.
- ✓ Where rainfall is irregular and insufficient to remove salts from the soil, coupled with high evaporation rates and poor natural drainage, results in salt accumulation or **salinization** on the soil surface.
- ✓ Soils with a lot of salts are saline and the state of having too much salts in the soil is referred to as **soil salinity.**
- ✓ The salts causes water deficiency and may lead to change of soil pH.

MAINTENANCE OF SOIL FERTILITY.

i. Control of soil erosion.

The measures to control soil erosion aims at promoting good water infiltration and reducing runoff.

Includes: terracing, contour cultivation, strip cropping, cut-off drains and planting cover crops.

ii. Crop rotation.

Practice of growing crops of different families on the same piece of land in an orderly sequence.

Helps to control crop pests, diseases and weeds.

Ensures maximum utilization of soil nutrients by growing a variety of crops which have different nutrient requirements.

Legumes in a rotation programme improves the soil nitrogen.

iii. Control of soil pH.

Most living organisms do well at a pH around neutral.

Extreme pH inhibit the activities of living organisms.

iv. Proper drainage.

Can be done by breaking hard layers impeding drainage. Where poor drainage is as a result of poor soil structure and texture, water channels can be used.

v. Weed control.

The weeds compete with crops for growth resources such as: nutrients, soil moisture, space and sunlight. Some weeds acts as alternate hosts of crop pests and diseases.

vi. Intercropping and mixed cropping.

Intercropping offers a better ground cover thus smothering weeds and controlling soil erosion. Legumes intercropped with cereals fix nitrogen which is used by the cereal crops.

vii. Minimum tillage.

Over cultivation destroys the soil structure leading to soil erosion. Therefore unnecessary land operations should be avoided.

viii. Use of manure.

Supply organic matter, which on decomposition releases nutrients into the soil. This increases the water holding capacity, moderates soil pH and improves soil structure which helps to control soil erosion.

ix. Use of organic fertilizer.

Chemical substances which are manufactured to supply specific plant nutrients. Once used they improves the soil fertility.

CHAPTER SEVEN
LIVESTOCK PRODUCTION: COMMON BREEDS

Livestock.
All those animals reared on the farm to directly benefit man. Includes; cattle, sheep, goats, pigs, poultry, rabbits, camel, fish, camel and bees.

IMPORTANCE OF LIVESTOCK.

a) Source of food.
Some animal's products are utilised as food. These include; meat, milk, eggs, honey and blood.

b) Source of income.
The various products are utilised at home and the surplus sold. The animals themselves can also be sold to earn income.

c) Cultural uses.
Includes.

d) Status symbol.
One is regarded to be wealthy on owning large herds of cattle, sheep or goats. Thus one becomes highly placed in the society.

e) Medium of exchange.
In olden days barter trade was the only of form of trade. Animals were thus used as medium of exchange.

f) Social ceremonies.
Some traditional ceremonies like marriage and funerals require the offering of live or slaughtered offering.

g) Recreational purpose.
These include activities like cock fighting, bull fighting, ostrich, camel, donkey and horse races.

h) Animal power.
Camels, donkeys and oxen are used to provide draught power which is needed in pulling of carts and ploughs.

i) Provision of raw materials.
- ✓ Animals are sources or raw materials for textile industry, theses raw materials include; wool, fur, mohair, hides and skins.
- ✓ The waste products such as dung are used in maintaining soil fertility.
- ✓ Cattle dung is used in synthesis of biogas.

COMMON LIVESTOCK BREEDS.

Breed.
A group of animals having the same characteristics and a common origin.

Cattle breeds.

Terms used to describe animals of different age and sex.

i) **Bull.** Mature male cattle.
ii) **Bullock.** Mature castrated male cattle.
iii) **Steer.** Young castrated male cattle.
iv) **Cow.** Mature female cattle.
v) **Heifer.** Young female cattle between weaning and first calving.
vi) **Calf.** Young one of cattle.

There are two categories of cattle breeds based on place of origin.

vii) Indigenous.
viii) Exotic cattle breeds.

Indigenous cattle.

i) Native or local cattle that have their origin within the tropics.
ii) Belong to a class called **Bos indicus.**
iii) They are not classified as breeds because of their variation in characteristics due to a lot of uncontrolled breeding over the years.
iv) Includes; the small East African Zebu which comprises of Maasai, Nandi, Ankole, Bukendi and Karamajong. Mainly kept for meat with little milk production.

General characteristics of indigenous cattle.

i. They have humps which stores fat, which is broken down to energy and water in times of starvation.
ii. They are fairly tolerant to high temperatures due to the presence of dewlap and thick hides.
iii. They have high tolerance to tropical diseases such as trypanosomiasis.
iv. They have slow growth rate leading to late maturity. Heifers are served at the age of 2-3 years.
v. They have low production of both meat and milk due to inheritance of poor characteristics.
vi. They can walk for long distances in search of food and water.
vii. They can stay for long periods without food and water without seriously affecting their performance and body condition.
viii. They have a long calving interval of more than one year.

Exotic cattle breeds.

Originated from temperate regions of Europe.
They belong to a class of cattle called **Bos taurus.**

General characteristics of exotic cattle breeds.

i. They have no humps.
ii. They have low tolerance to high temperatures and this makes them popular in cool climate of the Kenya highlands.
iii. They are highly susceptible to tropical diseases.
iv. They have a fast growth rate leading to early maturity. Heifers are served at 1 ½ -2 years.
v. They are good producers of both meat and milk.
vi. They have short calving intervals of one calf per year if well managed.
vii. They cannot walk for long distances.

They are further divided into groups namely:

i) Dairy cattle breeds.
ii) Beef cattle breeds.
iii) Dual purpose breeds.

1) Dairy cattle breeds.

General characteristics.

i. Their bodies are wedge to triangular shaped. This is due to heavy hindquarters with a tapering shape towards the head.
ii. They have a straight top line.
iii. They have a well set apart hindquarters to allow room for the big udder.
iv. They have large and well-spaced udders with large teats that are well spaced.
v. They have prominent milk veins.
vi. Their lean bodies carry little flesh. This is easily noted if the pin bone is visible.
vii. They have a large stomach capacity that enables the animal to feed heavily for high milk production.
viii. They are docile with mild temperament.

A. Friesian.

Origin. Holland. It is also known as Holstein.

with a few white marks. However, the tail switch, the leg parts below the knees and a patch on the forehead are always white.

Size.

Largest dairy breed. Cows weigh 550-680kgs and bulls 900-1000kg. Calves have a birth weight of 35-40kg.

Milk production.

Highest producing milk breed with an average of 9,150 kg per lactation of 305 days. Milk has low butter fat content of 3.5%.

Heifers reach service age at 21 months. Friesians are good feeders and requires large quantity of fodder.

B. Ayrshire.

CHAPTER EIGHT
AGRICULTURAL ECONOMICS

Economics.
Study of how man and society choose, with or without the use of money, to employ scarce productive resources to produce various commodities over time and distribute them for consumption now and in the future.

Agricultural Economics.
An applied science that aims at maximising output while minimising costs, by combining the limited resources to produce goods and services.

BASIC ECONOMIC CONCEPTS.
1) Scarcity.
Condition where the factors of production or resources necessary to satisfy production needs are limited in supply.
Production needs are unlimited thus a farmer is faced with the problem of limited resources to satisfy unlimited needs. Scarcity affects agricultural production in many ways for example a farmer may be unable to apply the recommended amount of inputs because of limited capital.
2) Preference and choice.
Preference is the selection of one thing or person over others.
Choice is the decision to select something.
Choice made is determined by such factors as the needs of the society, the farmer's preference and ecological factors.
3) Opportunity cost.
It is the value of the best forgone alternative.
Conditions under which opportunity cost is zero.
i) When there is no alternative.
ii) When goods are offered for free.
iii) When resources are not limited.

FARM RECORDS.
Characteristics of good farm records.

Uses of farm records.
- **i)** Records help to compare the performance of different enterprises within a farm or other farms.
- **ii)** They show the history of the farm.
- **iii)** Guide a farmer in planning and budgeting of farm operations.
- **iv)** Help to detect losses or theft on the farm.
- **v)** Help in the assessment of income tax to avoid over or under taxation.

vi) Helps to determine the value of the farm or to determine the assets and liabilities of the farm.
vii) Make it easy to share profits and losses in partnerships.
viii) Help in settling disputes among heirs to the estate when a farmer dies without leaving a will.
ix) Records help to show whether the farm business is making losses or profits. Helps the farm to obtain credit.
x) Help in supporting insurance claims on death, theft and fire of farm assets.
xi) Provide labour information like terminal benefits like NSSF dues.
xii) They help the farmer in selling certain assets like farm animals, machinery.

Types of farm records.

A. Production records.

Show the total yield and the yield per unit of each enterprise.

The table below shows milk production records.

Name/No of cow	DAYS IN THE MONTH									TOTALS.
	1		2		3		4		CONTINUE TO END OF MONTH.	
	Am.	Pm.	Am.	Pm.	Am.	Pm.	Am.	Pm.		
Kairu.										
Gatune.										
Vitallis.										
Mbogo.										
Total.										

B. Inventory records.

There are two types of inventory records.

i) Consumable inventory records.
ii) Permanent goods inventory records.

Consumable goods include; animal feeds, fertilisers, drugs and some construction materials like cement.
Permanent goods include; tools, equipments, machinery.

Example of consumable goods inventory.

RECEIPTS.			ISSUES.			
Date.	**Commodity/item**	**Quantity.**	**Date.**	**Issued to**	**Quantity.**	**Balance in stock**

Example of permanent goods inventory.

Date.	Commodity/item	Quantity.	Written off.	Balance in stock.	Comment.

C. Field operation records.

The farmer gives account of all that takes place in the field. For example the date of ploughing. Planting, fertilizer application. The records are kept per field or crop enterprises.

Season…… field No……
Net area……..
Crop grown ……. Variety…….
Ploughing date……. Planting date…….
Inputs:
……
Seed rate Kg/Ha……..
Fertilizer at planting: type…… Amount…….
Top-dressing: fertilizer…… Amount……..
Other
treatment……
……
Pests……. Control……
Diseases…… Control……..
Weeds…….. Control…… Other
treatment
……..
Output.
Harvesting date……. Method used……
Yield/ha……
……..
Remarks……
……..

At the end of the season the farmer should work out cost of production for each field using inputs records.

D. Breeding records.

Records kept to show the breeding activities and programmes for different animals in a farm.

Breeding records card for cattle.

Dam.		Breed Colour.	Parents: sire		Dam.
Dam No					
1st service	2nd service	3rd service	4th service.	Remark.	No of service.
Date of service.	Date of service.	Date of service.	Date of service.		
Time of service.	Time of service.	Time of service.	Time of service.		
Bull no Breed.	Bull no Breed.	Bull no Breed.	Bull no Breed.		
Pregnancy Diagnosis Date……..Results…….					
Expected date of calving.					
Actual date of calving.					
Weight of calf at birth.					
Sex of calf.					
No of calf					

Calving records.

Dam No	Sire No	Date of service.	Date of calving.	Weight of calf.	Calf number/name	Remarks.
Dam 1.						
Dam 2.						
Dam 3.						
Dam 4.						

In breeding of sheep and goats where individual animal records are difficult to keep the farmer can use a format for the whole flock which is illustrated below.

Sheep and goats breeding records.

No of Ewes/Does.	Service period (month)	Period of lambing/kidding. (month)	Lambing/kidding Percentage. %	No Weaned	Remarks.

The records format above is applicable where there is a definite breeding programme and Mating is restricted to a specified period.

Pig breeding records.

The record above shows breeding of sows within a year. It may be entered twice on the record if It farrows twice within the year.

Sow No……. Breed……	Sire No…… Breed……..	Date of service	Date of farrowing		Remarks.
			Expected.	Actual.	
Sow 1…….. ……					
Sow 2 ……... …….					

Individual sow breeding records.

Pen No…….	Dam No…… Breed. ……. Age of Dam……	Sire No…… Breed…….. Age of sire……	Service Date……... Farrowing Date…….. Litter size……
Age of piglets.	Average weight.	Total weight.	Remark.
Week 1.			
Week 2.			
Week 3.			
Week 4.			
Week 5.			

The individual sow breeding records above gives the details of the sow and its litter up to the time of weaning. The records helps in selecting a breeding stock. **E. Feeding records.**

Kept to show the types and amount of feeds used in the farm.

Daily feeding records in the month of…….. Enterprise…….. Type of feeds…….						
Date.	No of Animals.	Amount received. (Kg)	Amount used. (Kg)	Balance stock. (Kg)	in	Remarks.

F. Health records.

Records kept to show the health conditions of the animals on the farm. The records are Important during selection and culling of animals on health grounds. They help in calculating Cost of treatment and shows course of action to be taken in maintenance of health.

Date.	Disease symptom.	Animal(s) affected.	Drugs used.	Cost of treatment given	Remarks.

G. Marketing records.

Records that shows the commodity, quantity or amount sold, date, rate per unit of the Commodity, total value and where sold.

Commodity……..

Date.	Amount sold.	Price per unit (Kshs)	Total value. (Kshs)	Where sold.	Remarks.

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