ce and art of looking after livestock and growing crops to satisfy man's needs

NB: Agriculture currently contributes the biggest percentage of Uganda's income today.

Importance of Agriculture

- Is a source of raw materials used industries e.g. cotton for textile industries ,Hides and skins used in leather used in industry.
- Sugarcane – sugar industry.
- It provides employment both indirectly and indirectly like Agricultural officers, farm managers and accountants working in agriculture institutions.
- It is a source of income to the farmer through the sale of agriculture products.
- It is a source of food to both the rural and urban human population.
- It is a source of government revenue through taxation government revenue can be used to improve social services like health and education.
- It is a source of foreign exchange through agriculture exports.
- Agriculture is a source of energy used for other purposes e.g. Baggase (waste from sugar manufacture) can be used in producing electricity.
- Trade in agricultural products between countries brings about international relation.
- It can be a source of tourist attraction.

PROBLEMS OF AGRICULTURE IN UGANDA

1. Pest and diseases (These attack both crops and animals leading to low yields) To most destructive crop diseases in Uganda today are: coffee wilt, cassava mosaic, Banana bacterial wilt.

In animals the serious diseases are foot and mouth diseases, Nagana and contiguous abortions.

2. Poor transport and communication

Most of the feeder roads in rural areas are seasonally hence affecting transportation of our agricultural products to the market during the rainy season.

3. Natural disasters e.g. long drought and floods cause destruction of crop and animals leading to loses. This has been greatly caused by climate changes.

4 **Poverty**

Most of the rural farmers are poor therefore cannot afford the expensive agricultural unit like fertilizers, wood seeds and pesticides.

5. **Inadequate knowledge and skills:**
Most farmers lack enough knowledge which has greatly affected their level of production. E.g. most of them cannot read or write hence cannot take instructions on pesticides.

6. Poor crop varieties and animals breeds:
Crop and animals being raised are of low production leading to loses.

7. Poor technology/tools used
The majority of the farmers are using poor tools that cannot support large scale products.

8. Poor funding of agriculture sector by government.

9. The funding of agriculture are still very low which affect the level of production.

10. Price fluctuation. Due to over production and bad weather, prices for agriculture products are not stable which affect the farmer's income.

PROBLEMS OF AGRICULTURE IN UGANDA

High taxes on inputs
This makes agricultural products to be expensive as the cost of production increase.
Conservation
Due to the low education among farmers, they are not willing to change the doing of things.
Inadequate market information
Due to the low technology and remoteness of many rural areas access to market information by farmers difficult.
Competition at the world market
Due to low quality of agricultural produce in Uganda, it may not compete favourably with the product from the developed world.
Land degradation
Due to increasing human population, most of the land available has been over used leading to exhaustion.

SOLUTION FOR AGRICULTURE PROBLEMS

1. Farmers should be provided with loans at a low interest to be used.
2. Pests and diseases should be controlled through growing instant varieties, vaccination.
3. Agricultural research should be carried out improve the quality of seeds and animals.
4. Agricultural research station are Kawanda for crops,Serere for crops and animals Entebbe for livestock and Namulonge for crops and livestock
5. Agriculture should be processed to improve quality maintain prices in the market.

6. Storage structures should be constructed so that excess produce is store for future so as to maintain the prices.
7. Government should subsidize agriculture inputs to make it affordable to the farmers.
8. Compulsory, primary and secondary education should be encouraged so that all people receive education to fight ignorance and illiteracy.
9. Farmers should provide with enough marked information through the media and either means.

Local farming systems

1 Teso system

- It is common in the districts of Kumi and Bukenda.
- It is characterized by use of ox – drawn equipment like ox – ploughs.
- The area has light soils sparse vegetation which has encouraged the use of ox – culture.
- The main cash crop grown is cotton while other crops are finger millet, peas, sweet potatoes and sorghum.
- Intercropping is a common practice in this area.

2. Banana and coffee system

- This is practiced in the most fertile places in Uganda around Lake Victoria.
- It covers the districts of Mubende, Masindi, Wakiso, Jinja and some parts of Iganga, Luwero and Kamuli.
- The area receives two seasons of rainfall.
- The man cash crop grown is coffee (Robsta). The common food crops are bananas, sweet potatoes, maize and vegetables, sugarcanes and tea are grown at estates found in Lugazi and Kakira.
- A few animals are kept and ox – ploughing is not common.

3. Banana millet and cotton system

- It is common in the district of Tororo, Namutumba, Budaka, Kamuli, Kiro Nakasongola, Kayunga and parts of Masindi and Kilyandongo.
- Most of these areas have long period of rainfall which begins from April to November
- The main cash crop grown here has been cotton through Robusta coffee is also grown and some areas that have two seasons of rainfall.
- The food crops grown are sweet potatoes, cassava, Maize beans ground nuts and Banana.
- Ox – ploughing is done in some areas since they have light soils.

4. Northern system

This system is practiced in districts of Pachwechi, Gulu, Kitgum, Pader.
The major cash crops are cotton tobacco, sorghum figure millet pigeon peas,

simsim, Cassava, sun flower and Ground nuts.

- Intercropping is common while the use of ox-ploughing becomes less common as you move further in North.
- The area receives one long seasons of rainfall from April to October.

5. The west Nile system
   - This system covers the district of Arua, Koboko, Moyo, Adjumani.
   - The major cash crop in this area is cotton and tobacco though Arabica coffee is grown at a high altitude.
   - The food crops are finger millet, sorghum, millet, cassava and peas.

6. Montane system
   - It is practiced around the mountain ranges of Kigezi, Rwenzori and Elgon.
   - The system is similar to the banana, Robasta coffee system but it is modified by relief and population density.
   - The main cash crop from the area is Arabica coffee and tea.
   - The food crops are Bananas, Irish potatoes, Ground nuts, yams, beans, Sweet potatoes, maize etc.
   - Vegetables and fruit like passion fruit are grown for commercial purposes.

7. Pastoral system

It is practiced by the pastrol tribes of Uganda, i.e. Bahima and Karamajong, Ankole and Bahima.
They often live a nomadic way of life, moving from place to place with their animals.

They grow drought resistant crops like sorghum, bulrush millet, Ground nut and maize.

POPULATION AND AGRICULTURE

Population density is the number of people per square kilometer.

The human population of Uganda has been growing from about 3000,000 in 1962 to 33,000,000 today 2013.

Uganda has one the highest population growth in the world since the women are highly fertile having an average of seven (7) children each.

The highly population growth has a big influence in agriculture which neither negative or positive.

Positive effects of a high population in Agriculture.

- It provides enough labour used in agriculture.
- It provides market for agriculture produce.
- It provides high revenue that can be invested in agriculture to increase production.

Negative effects

- Land available for agriculture production reduces.
- It leads to land degradation due to continuous use of land.
- It may increase level of pollution in the environment as swamps and forests are redeemed.
- Most of the government funds will be spent on social services like education and health living out Agriculture.

CLIMATE AND AGRICULTURE

What is climate?

Climate is the average weather condition of a place recorded and studied for a long period of time.

Weather

Is the daily condition
Is the state of the atmosphere observed studied and recorded a short period of time.

Rainfall

It is the amount of rainfall in an area at a certain time.
Rainfall is measured using a rain gauge. The water is collected during the previous 24hours and measured and recorded. This is done every day for the moth to give a monthly total.

Types of rainfall

1. Relief rainfall
2. Convention rainfall
3. Frontal/ cyclonic rainfall
4. Convergence

The most important attributes of rainfall in agriculture are;

1. Rainfall distribution
2. Rainfall intensity
3. Rainfall effectiveness
4. Rainfall reliability

1. Rainfall distribution

This is the way rainfall is spread over the months in years.

The distribution of rainfall may be described in terms of rain season.

A place with two seasons is referred to as Bimodal rain while that one with a single long season is referred to as **Monomodal rain**.

Rainfall distribution may influence type of crops grown, time of planting and harvesting.

2. Rainfall intensity

This is the measure of the heaviness of rain over a given period of time.
It is measures using a rain gauge.

NB. High intensity of rainfall can result into erosion since the soil not be able to absorb most of the water.

3. Rainfall effectiveness

This is the measure of the amounted rainfall that is able to ensure successful growth of crops.

4. Rainfall reliability

This is the ability of rainfall to come as and when expected. This greatly influences the planting season.

EFFECTS OF RAINFALL IN AGRICULTURE

- It can cause pollination in crops
- It provides water/soil moisture needed for crop growth.
- It regulates soil temperatures
- It provides with water at the farm for washing, drinking etc.
- Provides water needed in seed germination.
- However, rain can be destructive through soil erosion and flooding.

Temperature

It is the measure of the hotness or coldness using a thermometer. Temperature is measures in degrees, centigrade (^{o}C) and degree Fahrenheit ($^{(o}F$).
To convert ^{o}C to ^{o}F

Example

The average temperature of Naalya s.s for the month of March was $28.5^{o}C$. Convert to degrees Fahrenheit

CLIMATE AND AGRICULTURE

Effects of temperature in Agriculture

1. Higher temperatures are used in drying crop produce.
2. It affects the rate of photosynthesis in crops.
3. It affects germination of seeds.
4. It affects the rate of transpiration in crops.
5. Higher temperature may increase the evaporation rate of water from the soil.
6. WIND

   This is moving air and its direction is measured by the wind vane. While the speed is measured by the Anemometer.

Importance of wind in Agriculture

It helps in seed dispersal

It is important in crop pollination
It is a source of power in wind mills
It is used in winnowing of seeds
It is used dying of crop produce
Wind currents can help in rainfall formation.

HUMIDITY

This is the amount of water vapour in the atmosphere. It is measured using a hygrometer.

Effects of humidity

- It affects the rate of transpiration in crops.
- It affects presence of fungal diseases.
- It influences the rate of dying crop produce.
- It may affects environment temperatures

LAND USE /LAND FORMS IN UGANDA

This is the way how land is put to use. In Uganda land is used in the following ways.

- We use land for settlement
- Agriculture
- Mining
- Burial grounds
- Transport and communication
- Industrialization
- Wild life
- Water bodies
- Forests
- Mortgage.

1. **Settlement**
   In this form of landuse, land is occupied by housing estates, schools, hospitals, urban centers etc.
2. **Agriculture**
   This is the biggest form landuse in Uganda. Land is put to a growing of crops and rearing of animals.
3. **Mining**
   This is land which is occupied by mines for copper, phosphates petroleum and sand.
4. **Wildlife**
   This is land occupied by National parks and game reserves.
5. **Water bodies**
   This covers lakes, rivers and springs.
6. **Tourism**

This refers to land which is occupied by national parks and game reserves. It is a very good source of foreign exchange for the country.

7. **Forests**

This land is occupied by natural and artificial forests in the different parts of Uganda.

Importance of forests

1. Important in rainfall formation (convectional rainfall)
2. They reduce global warming by absorbing excess carbondioxide from the atmosphere.
3. They provide timber that can be used in the construction of farm structure.
4. They can act as habitants for wild animals.
5. They are a source of herbs used in the manufacturer of medicine.
6. They attract tourists bringing in foreign exchange for the country.

Conservation of forests

These are measures aimed at preserving and protecting forests for generations to come.

Measures of forest conservation

Carrying out agro – forestry
Practice afforestation
Carrying out re – afforestation

1. **Afforestation**

More areas of land should be turned into forests by planting trees.

2. **Re – afforestation**

Every tree out should be replaced through planting other trees.

3. **Agro – forestry**

Trees should be integrated with crops and animals of forests

4. Government should set up strict laws against deforestation.
5. **Education**

People should be educated about the importance of forests.

6. Use of alternative sources

Government should encourage the use of alternative sources of fuel like biogas, petroleum, solar.

7. Rural electrification should be encouraged to reduce the dependence

FARMING SYSTEM

Subsistence farming

This is the growing of crops for consumption and selling the surplus.

Forms of subsistence farming

- Shifting cultivation

- Rotational bush furrowing
- Nomadic pastoralism.

Advantages of subsistence farming

- It requires les land to be practiced.
- It requires less initial capital
- It requires simple tools that are cheap
- It requires less labour since it mainly depends on family labour. (Women and children).
- It requires less skills to be practiced.
- It uses cheap inputs.

Disadvantages of subsistence farming

- It leads to poverty because the peasants lack income
- Production is low which may easily lead to food.
- It reduces government revenue since peasants are difficult to tax.
- It may lead to soil exhaustion due to poor methods of farming practiced.
- It increases unemployment in the community.

Shifting cultivation

This is where a farmer clears land uses it until it loses fertility then she/he moves to fresh place.

Characteristics of shifting cultivation

- Land is cleared by cutting and burning vegetation.
- It is practiced in areas with low human population
- Simple tools are used
- Small areas are cleared
- Few annual crops are grown.
- Intercropping is common
- Little attention is given to the crops
- Crops are mainly grown for home consumption.

Advantages of shifting cultivation

1. It uses simple tools therefore it is cheap to maintain.
2. The use of fire makes clearance of land easy
3. Bush burning adds, more minerals to the soil.
4. Intercropping guards against crop failure.
5. It is easy to control pests and diseases since the farmers can move to a fresh place.
6. Crop yields are usually high due to use of fresh land.
7. There is less weeding as the fire used can burn weeds seeds.

Disadvantages of shifting cultivation

1. Bush burning leads to the destruction of soil living organisms.

2. It can only be practiced in areas with low population.
3. It cannot provide enough food for a big population.
4. It may leave the land bear and exhausted which exposes it to erosion.
5. It leads to massive destruction of forests.

Nomadic Pastoralism

Nomadism: Means moving from one place to place to another.
Pastoralism means rearing of animals more especially cattle.
Therefore
Nomadic Pastoralism
Is the practice is the rearing of cattle while moving from one place to another. In search for water and pastures for the animals.

Characteristics of nomadic Pastoralism

1. They keep very large number of animals.
2. There is movement from place to place.
3. There's growing of few annual crops on a small scale.
4. Animals kept are of poor breeds.
5. Poor animal husbandry practices are carried out.
6. Over grazing is common which leads to soil erosion.
7. Animals depend on natural pastures.
8. Animals are grazed on land owned by the community.
9. The practice is mainly carried out in the arid and semi-arid areas.

Problems faced by pastoral nomadism

1. Poor weather leading to drought.
2. Walking long distances
3. Lack of pasture for the animals
4. Poor breeds of animals kept.
5. Cattle rustling which leads to death
6. Lack of water for animals
7. Parasites which attack animal leading to poor breeds.
8. Pastoralists may be attacked by tropical diseases which lead to death.
9. Conservatism.
10. Poor veterinary services
11. Poor housing of animal
12. Shortage of land

INTERCROPPING

This is the growing of a major crop together with a minor crop on the same piece of land at the same time. E.g. maize and beans, cassava and beans, maize and groundnuts, coffee and banana.

Advantages of intercropping

1. A farmer may get a balanced diet when her production legumes and cereals at the same time.
2. A farmer gets double income after selling the 2 crops.
3. The weak plants can be supported by the strong ones e.g. maize can support the climbing beans.
4. Growing legumes together with other crops maintains soil fertility since nitrogen is fixed by the legumes.
5. It guards against total loss to the farmer since failure from one crop can be covered by the other.
6. Production per available land is high since land is utilized maximally.
7. Weeds are easily controlled since they are denied space.

Disadvantages of intercropping.

1. It is difficult to weed a garden that has more than one type of crop grown together.
2. The number of pests and diseases increase due to a variety of food source.
3. There is high competition of nutrients between crops which may result to low yields.
4. Spraying of crops against pests and diseases is difficult.
5. Much more labour is required in carrying out agronomic practices.
6. It can easily lead to soil exhaustion due to the high intake of nutrients from soil by the different crops.
7. Difficult to use machines when carrying out operations like weeding.
8. It is difficult to apply fertilizers and manures to the crops in the garden.

Modern farming/systems

1. Mixed farming
2. Plantation farming
3. Intensive farming

1. A farmer gets double income i.e. from crops animals sold.
2. A farmer gets a balanced diet by eating crops and animals products.
3. Animals can provide manure (from yard manure) that can be used to improve soil fertility for proper crop growth.
4. Crop residues and products can be fed to animals therefore reducing feed costs.
5. The practice guards against total loss to the farmer since failure in crops can be compensated by animals.
6. Animals can provide labour used in Ploughing and transportation of plant produce.
7. It ensures income to the farmer throughout the year.
8. Labour is efficiently utilized throughout the year.

Disadvantages of mixed farming

- It requires a high initial capital
- It is expensive to maintain
- It requires a large piece of land to be carried
- It requires more skills to be carried out.
- It requires much more labour
- It requires a large piece of land to be carried out.
- It requires much skills to be carried out

Plantation farming

This is the growing of one type of crop on a large scale using scientific methods of farming.

The plantations can also be referred to as estates.
In Uganda, sugar cane and tea are the main crops grow on plantations.

Characteristics of plantations

1. The form concentrates on production of a single crop e.g. sugarcane plantations in Kakira, Lugazi and Kinyara.
2. The farm covers hundreds of hectares
3. Crops are grown for commercial purposes
4. There's use of machines when carrying out farm operations
5. A lot of capital is required to set up a plantation.
6. It employs a large labour force
7. Scientific methods of farming are used

Advantages of plantation farming

1. It provides employment to both skilled and unskilled labour
2. It is a source of government revenue through taxation.
3. They earn foreign exchange to the government by exporting products
4. They engage in Agriculture research which encourages development
5. They provide high quality agriculture products.
6. The encourage development of outgrowers.
7. Plantation provide social services e.g. health and education to the workers

Disadvantages of plantation farming

1. It may lead to displacement of people during establishment.
2. Production of a single crop on the same piece of land for a long time may lead to soil exhaustion
3. Plantations may cause environmental degradations by encroaching on forests and wetlands
4. It requires a lot of capital to establish a plantation.
5. Foreigners who own these plantations take most of the profits outside the country.

Intensive farming
This is the use of scientific methods of production in agriculture on a small area to produce high yields.
The scientific methods of production are;
(i) Use of fertilizer and manures
(ii) Use of pesticides i.e. Herbsites, insecticides, acasides, wormicides etc
(iii) Use of drugs and machines to treat livestock
(iv) Irrigation of crops
(v) Use of improved crop seeds and animal seeds.
(vi) Use of machines in carrying out farmwork
(vii) Use of high quality labour /skilled labour
(viii) Use of green houses in growing crops

SOIL

This is a mixture of weathered rock materials and organic matter which are formed through physical, chemical and Biological processes.

Or

It is the outer most layer of the earth's crust where plants grow and derive nutrients.

Or

It is a natural body of loose unconsolidated material which constitutes a thin layer of several meters deep on the earth's surface.

SOIL FORMATION

Soil is formed through the process of weathering.

WEATHERING

This is the process of breaking down or the disintegration of rocks to form soil.

The rocks that form soil are of three types i.e. igneous rocks, sedimentary rocks, and metamorphic rocks.

IGENEOUS ROCKS

These are rocks formed by the cooling and solidification of molten magma (Larva) extracted at high temperature from the interior regions of the earth's crust near on the surface of earth.

The main types of igneous rocks are:-

Granite, diorite, and basalt and gabbro. The minerals present in these rocks are mica, feldspar, quarts, iron oxides and biotite.

SEDIMENTARY ROCKS

These are formed by the deposition of weather minerals which are derived from igneous rocks. E.g. shales, sand stone, and limestone. The minerals in these rocks are clay minerals, quartz, calcium, phosphate, dolomite, iron oxides.

METAMORPHIC ROCKS

These are formed by the action of heat, pressure and chemical changes on igneous and sedimentary rocks e.g. gneiss, schist, slate, and quartzite

TYPES OF WEATHERING

There are three main types of weathering i.e. physical weathering, chemical weathering and Biological weathering.

PHYSICAL WEATHERING

This is the mechanical disintegration of rocks which is caused by heat, roots of trees, ice, wind and rain.

HEAT

When rocks are heated, they expand unevenly between their layers. A change in temperature will set up stresses which will result into breaking of rocks.

ICE

When water cools to form ice, it expands. Therefore the presence of water in rocks cracks can lead to the breaking of rocks when it cools to form ice

RAIN

Rainfall particularly that with hail stones falls on rocks surfaces crashing and removing some particles from them which are carried by the running water.

WIND

As strong wind, blows it carries away tinny rock particles to different places from the mother rock.

PLANT ROOTS

As roots penetrate through the rock cracks, they will cause further cracking as they increase in size through growth.

CHEMICAL WEATHERING

This is aided by physical weathering which increases a greater surface area of rock exposed to chemical weathering. Chemical weathering is the chemical transformation or decomposition of parent rock mineral materials into new mineral complexes.

TYPES OF CHEMICAL WEATHERING

This includes hydrolysis, hydration, oxidation, carbonation, reduction, and solution.

HYDRATION

This occurs when water combines with minerals, silicates and oxides of iron or aluminum to form hydrated compounds e.g.

The hydrated compound are softer than the original rock and therefore easily worn away.

OXIDATION

This is where atmospheric oxygen and free oxygen contained in rain water convert rock minerals to oxides. These oxides usually take more space and thus help to break up the rock e.g.

HYDROLYSIS

This is the use of water to break up chemical bonds of a particular compound e.g

REDUCTION

This occurs in wet, badly drained and poorly aerated sights such as deep zones of the earth's crust. It involves the removal of oxygen from minerals

SOLUTION

Water is the most important chemical weathering agent in most kinds of rocks through its solvent action when it dissolves water solvent minerals of rocks, it participates actively in weathering.

CARBONATION

Water and carbondioxide combine to form a weak carbonic acid which reacts with oxides of calcium and magnesium to form carbonate and bi-carbonates.

BIOLOGICAL WEATHERING

This is the weathering which is influenced by living organisms like bacteria, fungi, nematodes, lichens and mosses. A part from decomposing dead animals and plants to form soil, they produce acids which act on rock minerals and weaken it.

FACTORS AFFECTING SOIL FORMATION

CLIMATE

- The development of soil profile is largely controlled by temperature and precipitation (rainfall). Enough moisture in the soil encourages micro organisms to carry out decomposition while in the soil.
- It influences vegetation and therefore type of soils formed.
- High temperatures discourage microbial activities of organism in the soil.
- Varying environmental temperature can cause breaking up of rocks to form soil.

LIVING ORGANISMS

- Living organisms like bacteria and fungi carry out decomposition of dead plants and animals remain leading to soil formation.

- The termites are able to convert wood into soil because they have the cellulose enzymes in their guts which act on cellulose in wood.
- The vegetative cover protects the soil surface from soil erosion hence minimizing soil loss.
- Living organisms die and decompose to form soil
- Leaves from trees fall and provide organic matter
- Earth worms grind up mineral particles important in soil formation

PARENT MATERIAL

The main features of the parent materials here are texture, chemical and mineral composition of the soil.

Soils developing from limestone are usually fine textured and higher in inorganic matter than those formed from coarse textured material.

TOPOGRAPHY (RELIEF)

- This influences the amount of rainfall received in an area,
- Surface erosion which determines soil depth by removal and deposition of soil
- Water infiltration into the soil.
- It also influences vegetation through its influence on rainfall hence affecting soil formation.

TIME

It requires a lot of time for a soil to develop up to full maturity. A mature soil will contain all the required nutrients needed by plants. Conditions which speed up soil formation are; warm humid climate, flat topography and forest vegetation. The factor slowing down soil formation is cold or hot day climate, grass vegetation, slopping topography.

HUMAN INFLUENCE.

Humans tend to disrupt soil formation through disturbing soil profiles during the construction of buildings, roads and dams. Their practice of bush burning destroys organic matter and raises soil temperature, slowing down the process of soil formation.

Man can transform soil in the following ways;

- Natural vegetation is destroyed in getting land for agriculture
- Fertilizer application interferes with the chemical nature of soil
- Topography is altered through constructions of roads and buildings
- Application of pesticides changes chemical soil properties
- Soil cultivation destroys soil structure
- Irrigation may interfere with soil nutrient composition and structures

Soil formation involves 3 stages of disintegration, decomposition and translocation.

Disintegration; breaking up of parent material

Decomposition; process of decomposing organic materials

Translocation; removal of soil or vertical movement of particles and dissolved solids with in a profile and often into the ground

Soil profile

This is the vertical section of the soil through all its horizons/layers and down to the parent material

Top soil/A HORIZON

It's darker in colour because of high organic matter accumulation

It's an area of eluviations as plant nutrients are removed by leaching

Its more subject to weathering and cultivation operations

Its well aerated and has active micro organisms

The dark colour is ainly due to organic matter in soil

Subsoil / horizon B

It's a zone of illuviation as materials from top soil are deposited here

It's more compact than top soil

It's less aerated

Hard pans are mainly found in this region

In young soil, the B horizon is absent

The brown colour is due to the iron oxides in this horizon

Parent material /Horizon C

Contains broken down rocks

It has clay material

Zonal soils is one where climate and vegetation have played part in formation

Azonal is produced by deposition of material and without a soil profile

Intrazonal soils are formed basing on parent material

a. Podzol profile
b. Ferralsol profile.

A podzol profile displays sharp contrast between the horizons and its widely distributed in humid temperate areas.

Ferralsol: It is an example of soil that has developed under humid tropical conditions through progressive weathering of rock.

N.B. Soil catena is the sequence of soil developed from a similar parent rock material under similar climatic conditions but whose x-tics differs due to difference in relief and drainage

PROPERTIES OF SOIL

These include soil drainage, water holding capacity, plasticity, aeration, fertility, structure, density texture, porosity, colour, soil fauna, PH, and productivity.

SOIL TEXTURE

This is the proportion of sand, silt, and clay in a particular soil. Soil texture affects the following:-

a. The circulation of air in the soil (soil aeration)
In fine textured soils, there is limited movement of air due to the small spaces.

b. Water holding capacity,
This is higher in fine textured soils like clay than coarse textured soil like sand.

c. Root penetration
This is higher in coarse textured soils and lower in fine textured soils since the fine particles resist root penetration.

d. Response of plants to fertilizers
Poor root penetration means limited response to fertilizers hence fine textured soils are not good when it comes to movement of nutrients.

e. Rate of chemical reaction in the soil
Poor textured soils would limit soil reaction like carbonation, hydration and hydrolysis.

SOIL TEXTURAL CLASSES

This is done according to the United States Department of Agriculture and the international soil science system.

USDA classification

Soil separate	Particle diameter (mm)
Very course sand	2.00 – 1.00
Course sand	1.00 – 0.50
Medium sand	0.50 – 0.25
Fine sand	0.25 – 0.10
Very fine sand	0.10 – 0.05
Silt	0.05 – 0.002
Clay below	0.002

SOIL TEXTURAL CLASSES (SOIL TYPES)

There are three main textual classes (types) i.e. clay soil, Sandy soil and loam soil.

These three give rise to other classes depending on the percentage of sand silt and clay present in a particular soil e.g. sandy clay, clay loam, silty clay loam, sandy clay loam,

loamy clay sand and silty clay.

PROPERTIES OF TEXTUAL CLASSES

Clay soil

- It has a high water holding capacity
- It has a high nutrient holding capacity.
- It has small air spaces
- It is not gritty
- It is not smooth
- It forms extremely cohesive balls and long threads which bend into rings easily when wetted.

Sandy soil

- It is extremely gritty
- It is not smooth
- Its not plastic
- It forms non cohesive balls which collapse easily
- It has a low water nutrient holding capacity
- It has big air spaces
- It has big soil particles.

LOAM SOIL

- It is moderately gritty
- It is slightly smooth
- It is slightly sticky
- It is slightly plastic
- It forms moderately cohesive balls
- It forms long threads which bend into rings with difficulty.
- It has a moderate water holding capacity
- It contains 5 – 10% organic matter
- Loam soil is an optimum mixture of sand, silt and clay.

Experiment to determine the different sizes of particles present in the soil:-

- Place 40g of soil in 100cm3 measuring cylinder
- Fill the cylinder with water up to ¾ of it
- Cover the open end firmly with land and shake the content of the cylinder vigorously
- Stand the cylinder on a land flat surface and observe how the suspension settles down.

Results

- Some bubble escape from the container indicating the presence of air.
- After shaking, the largest particles fall to the bottom (sand) followed by fine sand, silt, clay and finally organic matter.

BULK DENSITY

This is the mass per unit volume of un disturbed soil dried to consistent weight at 105^0C.

Bulk density = $\frac{\text{weight of oven dry soil (g)}}{\text{The volume of the oven dry soil (cm}^3\text{)}}$.

This property affects
Water holding capacity
Soil aeration
Crop root development
Seed germination

PARTICLE DENSITY

It's the ratio of weight of solids to volume of solids in soil g/cm^3. the solids in soil are organic matter, inorganic matter, and living organism. In the calculation of particle density, volume of air should be excluded.

SOIL PLASTICITY

This is the capacity of the soil to be molded without breaking or rupturing.

The terms used in describing the degree of plasticity are non plastic, slightly plastic, plastic and very plastic.

SOIL CONSISTENCY

This is the degree of cohesion of soil or the resistance of the soil to deformation is measured by filling and manipulating the soil by hand or pulling tillage equipment through it. The classes of consistence include:-

SOIL POSOSITY

This is the measure of the size of pore space in soils. In soils where the particles are closely together, there is limited pore space and therefore less air in such soils and poor plant root development.

SOIL STRUCTURE

This is the arrangement or grouping of soil particle in a particular soil. Soil structure affects water movement, heat transfer, aeration, bulk density and porosity.

TYPES OF SOIL STRUCTURE

i. Platy structure.

Here the soil aggregates are arranged in a relatively thin horizontal plates or leaflets. This type of structure is more common in the surface layer of virgin soils.

ii. Prismatic structure.

This includes columnar type and prismatic type. Both types are usually found in sub soils in arid and semi arid regions.

iii. Blocky structure.

This structure has two sub-structures like cube like and sub angular in heavy sub soils particularly those of humid soils.

iv. Spheroidal structure

This consists of sub-structures like granular where the aggregates are porous and crumb where the aggregates are very porous.

v. Crumb structure

This is commonly found in top soil and particles are granulated

SOIL FERTILITY.

This is the ability of the soil to supply plant nutrients in adequate amount and right proportion for better plant growth.

FACTORS AFFECTING SOIL FERTILITY.

Soil depth, soil structure, soil drainage, soil PH, soil aeration, water holding capacity, availability of plant nutrients, presence of pests and diseases, soil compaction, living organisms, accumulation of salts, soil capillarity, hard pans, soil capping and presence of polyethene materials in soil.

SOIL DEPTH

Soil depth is associated with the maturity of the soil and it also influences the amount of water retained in it for plant use.

SOIL STRUCTURE

This affects the amount and movement of air and water within the soil and also the transfer of heat. Therefore a good soil structure gives ideal conditions for plant growth.

SOIL DRAINAGE

This refers to the ease with which excess water drains out of the water logged soils. There is poor aeration, low temperature, poor soil structure, and low PH in water logged soils. All the above will interfere with normal crop growth.

SOIL AERATION

Adequate air in the soil particularly oxygen improved water and nutrients uptake and also encourages better root development. The air is also needed by the soil organisms during the decomposition of plant or animal remains.

POLYETHENE MATERIALS IN SOIL

Affects soil aeration, root development and water infiltration which all affect soil fertility

SOIL CAPPING

This affects soil drainage which determines pest attack, soil Ph and root development in crops and hence soil fertility.

HARD PANS

This impedes water infiltration hence affecting soil fertility.

AVAILABILITY OF PLANT NUTRIENTS

Plant nutrients are needed by plants and therefore a soil which contains most of the nutrients and can easily supply them is said to be fertile.

SOIL PH (SOIL REACTION)

This is the acidity or alkalinity of the soil. It influences the (ability) availability of plant nutrients e.g. at lower PH (acidic) phosphorous and molybdenum are not available but iron, Mg, Zn, K and Boron are available yet unavailable again at high PH (alkaline)

IMPORTANCE OF SOIL PH.

- It affects the presence of certain plant pathogens like bacteria and fungi are not common at low PH but fungi are common
- At very low PH the concentration of certain nutrients such as iron and Aluminium in the soil becomes toxic to plants.
- Soil PH has a strong influence on the availability of various plant nutrients.
- Very low or very high PH inhibits the activity of the soil micro-organisms more especially the nitrifying bacteria.

    - Sugar factory lime
    - Calcium hydroxide
    - Calcium magnesium carbonate

LOSS OF SOIL FERTILITY

Soil can loose fertility through:-

Soil capping
Change of soil PH
Build up of pests and diseases in the soil
Burning
Formation of hard pans
Soil erosion
Over cultivation
Crop removal during harvesting
Large number of weeds.

Soil Capping

This is the formation of an impervious layer on the surface of soil which prevents water infiltration. This stops the dissolution of plant nutrients and proper root development

Formation of Hard Pans

This is an impervious layer formed just beneath the soil surface and can be caused by continuous ploughing at the same depth. It prevents water percolation and proper crop root development.

Over cultivation

This causes rapid oxidation of organic matter by micro organisms leading to loss of fertility.

Effects of over cultivation of arable land

- Destroys Soil structure making the land more prone to erosion
- Increases production costs by engaging more labour in cultivation
- Can destroy crop roots
- Can increase evaporation of moisture from soil by increasing surface area for water loss.
- Increases oxidation of crop nutrient hence loss of fertility

Crop removal during harvesting

The removal of crops from the garden or their products from the garden carries away all the nutrients concentrated in their tissue and seeds.

Weeds over growth

These use a lot of nutrients and therefore cause loss of nutrients from the soil

Leaching

This is the washing out of soil nutrients in both solution and suspension to the deeper layers of the soil where plants can not utilize it.

Soil erosion

This carries away the more productive top layer of soil leading to loss of fertility

Change of soil PH

Some plants nutrients are available at low PH e.g. iron, Mg, A1, Zn, K and Boron while others are favoured by a high PH e.g. phosphorous and molybdenum

Build up of pests and diseases

This may be caused by mono-cropping and therefore less products expected from such a soil.

MAINTAINANCE OF SOIL FERTILITY

The fertility of the soil can be maintained through the following ways:-

1. **Crop rotation:** Is the growing of different crops on the same piece of land in a particular sequence season after season for proper utilization of nutrients

Follow the guide lines.

- Legumes should alternate with other crops since they increase soil fertility by fixing nitrogen
- Crops with high nutrient requirement should come first on a newly cultivated piece of land to utilize a high content of nutrients present at this stage.
- Deep rooted crops should alternate with the shallow rooted crops since deep rooters bring nutrients to the upper layers of soil for shallow rooters to use
- Cover crops should be included in the rotation to control erosion.
- A fallow period should be included in the rotation to preserve soil structure and restore the lost nutrients.
- Crops that are easy to weed should alternate with those that are difficult to weed.
- Crops attacked by similar pests and diseases should not succeed one another in the rotation to reduce spread

Importance of crop rotation

- There is maximum use of soil nutrients since different crops with different nutrients requirements are involve in the rotation.
- Pests and diseases are easily controlled by breaking their cycle and starvation.
- Parasitic weeds like *string spp* in sorghum are easily controlled under crop rotation.
- The nitrogen content of the soil can be improved more especially if legumes are included in the rotation.
- Good rotation evens out Labour requirement throughout the year.
- It spreads financial risks over several crops
- Some deep rooted crops in the rotation will recycle nutrients.
- Soil erosion can be controlled during the fallow period when grasses are allowed to grow on the land or by the binding action of the plant roots.

An example of a four year crop rotation

Year	Plot 1	Plot 2	Plot 3	Plot 4
1	Sweet potatoes	Beans	Cassava	Millet
2	Millet	Sweet potatoes	Beans	Cassava
3	Cassava	Millet	Sweet potatoes	Beans
4	Beans	Cassava	Millet	Sweet potatoes
	Fallow	Fallow	Fallow	Fallow

NB After the fourth year the farmer can decide to have a fallow period

Limitations of crop rotation

Shortage of land due to an increasing human population

Presence of permanent building that cannot be rotated

Introduction of perennial crops with a long gestation period

Merits of the practice cannot be easily recognized by farmers hence difficult to convince them

2. **Proper weed control**: weeds compete with crops for soil nutrients. A high population of weeds will extract a lot of nutrients from the soil making it infertile in the long run.
3. **Mulching**: Is the covering of top soil with dry plant materials or artificial substances like polythene papers. Apart from conserving the soil moisture and suppressing weeds, mulches also rot and add fertility to the soil.
4. **Minimum tillage**: Minimum disturbance of the soil will conserve its organic matter content and moisture hence maintaining fertility.
5. **Soil pH control**: At different pH some macro and micro elements are present while others are absent. The soil pH can be maintained through liming and addition of fertilizers.
6. **Addition of manure**: The addition of both organic and inorganic manure will increase the amount of soil nutrients therefore maintaining the fertility. However, over use of artificial manure can cause acidic conditions in the soil that may lower soil fertility.
7. **Soil erosion control**: The washing away of he most fertile top soil leads to loss of soil fertility as well. Methods of controlling soil erosion like terracing, mulching, contour ploughing etc should be used.
8. **Improving on soil drainage**: This will eliminate water logging with all its disadvantages like increased leaching
9. **Improving on the water holding capacity of the soil**: Water is needed by plants in the absorption of soil nutrients and in photosynthesis therefore water holding capacity of the soil should be improved to maintain the soil fertility through the addition of organic manures.

COMPONENTS OF SOIL

Soil is composed of living organisms (micro and Macro), air, mineral elements, organic matter and water.

Living organisms

These include micro organisms like bacteria, fungi, protozoa, etc. It also includes macro living organisms like earth worms and some insects.

Importance:

- They carry out decomposition of dead plants and animals remains to produce humus which is used by plants.
- Some bacteria like Rhizobia fix nitrogen into the soil
- After their death more especially the macro organisms decompose and add fertility to the soil.
- Other living organisms like earthworms, excrete urea which adds fertility to the soil by providing nitrogen.
- They aerate the soil by making tunnels. The more tunnels, the more the aeration.

AN EXPERIMENT TO SHOW THAT SOIL CONTAINS LIVING ORGANISMS.

Apparatus

- 2 conical flasks
- Lime water
- 2 muslin bags
- 2 samples of soil i.e. sample A sterilized soil and sample B fresh top soil.

Procedure

Label the conical flasks i.e. A and B
Pour about 10cm3 of lime water in each of the flasks.
Put fresh top soil in the muslin bag and hung it in the conical flask A and sterilized top soil in another muslin bag in B as shown below.

Observation:

After 8 hours the lime water in flask A will turn milky while in flask B there will be no observable change.

Conclusion

The lime water in flask A turned milky due to the presence of living organism in the soil that respire releasing carbondioxide which turns lime water milky.

SOIL AIR

Soil contains air, the biggest portion being CO_2 and O_2. Soil air is used by living

organisms in respiration and also the plant roots.

N.B. Water and air occupy the same position and therefore high level of water in the soil will reduce the amount of air in that particular soil.

Apparatus:

Soil sample
Distilled water
A beaker
Stirring rod

Procedure

Put the dry soil sample in the beaker to cover ¼ of it.
Pour twice the volume of soil water, and stir continuously

Observation

Air bubbles are seen coming out of the water in the beaker

Dry soil contains air.

EXPERIMENT TO DETERMINE THE AMOUNT OF AIR IN SOIL

Apparatus:

Dry soil sample
At least two measuring cylinders
Distilled water
A beaker.

Procedure:

Measure off 50cm^3 of dry soil and transfer to another dry measuring cylinder.

Measure off 50cm^3 of water and add it to the soil in the measuring cylinder.

Observation

Bubbles of air are seen escaping when the two are added and the volume of the mixture is less than the expected 100cm^3.

Conclusion:

The difference between the expected volume of the mixture (100cm^3) and the actual-volume will be that of air e.g. (50 + 50) cm^3 = 100cm3 expected.

Actual = 70cm^3
100 – 70 = 30cm^3 Air = 30cm^3

EXPERIMENT TO DETERMINE WHETHER SOIL CONTAINS WATER

Apparatus

Dry soil sample
Boiling test tube
Heat source
Stirring rod.

Procedure

Pour dry soil up to 1/3 of the test tube.
Put the test tube on a heat source for about 5minutes.

Observation:

As the heating goes on, vapour condenses at the cooler part of the test tube.

Conclusion

Soil contains water.

SOIL PERMEABILITY.

This is extent to which a soil allows water to pass and spread through it. However sometimes soil permeability and soil drainage are considered to be the same.

Soil drainage

Refers to the relative ease by which water passes through the soil.

EXPERIMENT TO SHOW WATER RETENTION (DRAINAGE) IN SOIL

Apparatus

Atleast 3 filter funnels
Filter paper / cotton wool
Three soil samples i.e. clay, sand, and loam
Clean water
Stop clock
Atleast three measuring cylinders
Arrange the practical as below:-
Water should be added to each of the funnels in the same quantities. A stop clock should be used to measure the time taken for a particular quantity of water to pass through each sample.

Observation:

After a specific period of time its observed that clay soil retains a lot of water than loam and sandy soils. Therefore clay soil is poorly drained while sandy soil is well drained.

EXPERIMENT TO FIND OUT THE AMOUNT OF ORGANIC MATTER IN THE SOIL

Apparatus needed

Heat source	evaporating dish	Tippled stand
Weighing balance	Stop Clock	Stirring rod
Soil sample		

Procedure

Weigh the evaporating dish and its weight recorded as X g

Weigh a dry sample of soil and call it W g.
Add the two weights and the total should be called “y” i.e. (CX+W) g = Yg.
Place the dish with the soil on heat source for about 30 minutes.
Remove the dish after that time and cool it.
Weigh the dish and the soil and call it Zg
The weight of organic matter in soil = Yg-Zg =P g
Pg is the loss in weight as a result of loss due to organic matter.

SOIL PRODUCTIVITY.

This refers to the ability of the soil to produce and sustain high crop yields.

CHARACTERISTICS OF PRODUCTIVE SOIL

- It should be well drained.
- It should be of a sufficient depth for good root penetration and growth.
- It should be well aerated.
- It should have a good water holding capacity.
- It should have enough nutrients which must be the right proportions.
- It should be fee from crop pests and diseases.
- It should have a right PH for the particular crop to be grown on it.
- It should have a good structure and texture.

SOIL SAMPLING

it is the collection of various samples of soil from different locations of a piece of land for laboratory analysis

Reasons for soil sampling

- To determine soil fertility

- to determine soil structure
- to determine soil texture
- to know the best type of crop to grow
- to determine the water holding capacity of soil
- to determine water holding capacity
- to determine organic content of soil
- to determine soil aeration
- to know the best crop to grow on soil
- to know the type of fertilizer to use

Equipment needed in soil sampling

1. garden trowel
2. soil auger
3. hand hoe
4. labels
5. polyethene paper

Methods of sampling

1. transverse sampling
2. Zig zag sampling
3. spot sampling

procedure of sampling

- obtain clean and complete equipment to use
- determine the area to be sampled to know the number of samples needed
- choose the best method of sampling to use
- choose the sites to collect samples and avoid old house sites, rubbish pits, wet areas, anthills, boundaries and under shades
- clear all vegetation at selected sites to exclude plant materials
- collect soil up to a depth of 15 cm from different sites
- add the different samples to make a composite sample
- thoroughly mix the samples by breaking the big clodes
- make two representative samples of one kilogram each
- label the representative samples and send it to the laboratory
- carry out the required analysis

PLANT NUTRIENTS

Plant nutrients can be divided into two major groups i.e. Macro and Micro nutrients.

Macro nutrients (major elements)

These are nutrients needed by plants in large quantities e.g. carbon, oxygen, hydrogen, nitrogen, phosphorous, potassium, calcium, magnesium and Sulphur.

Micro elements (trace elements)

These are nutrients needed by plants in small quantities though they are very important for plant growth. E.g. iron, manganese, copper, molybdenum, zinc, chlorides and cobalt.

Macro nutrients

Nitrogen:

This is one of the most important elements needed by plants yet its deficient in most areas of East Africa.

Uses of nitrogen to plants

- Its necessary for the formation of chlorophyll
- It improves the quality and quantity of leaf crops such as cabbages, dodo, etc.
- It is a constituent of plant proteins.
- It helps in cell division and therefore responsible for growth
- Controls the use of phosphorus and potassium in the plants.

Deficiency symptoms of Nitrogen in plants.

- There is restricted root development
- Plants become stunted.
- There is even yellowing and loss of leaves
- There is pre-mature ripening of fruits.

Signs of excess nitrogen in plants.

- Excessive leaf production
- Delayed maturity
- Leaf and stem logging
- Scotching of leaves
- Poor crop yields

Fate /loss of nitrogen from the soil

- Crop removal during harvesting
- Soil erosion.
- Through leaching
- Burning of crop residues
- Volatilization (denitrification; oxidation of nitrates to atmospheric nitrogen)
- leaching
- monocropping

Sources of nitrogen

Commercial fertilizers e.g. NPK, Urea, CAN, Sulphate of ammonia, Diammonium phosphate (DAP)

Organic fertilizers like farm yard manure, compost manure and green manure.

Lightening.

PHOSPHOROUS

Importance

- Encourages the formation, development and establishment of roots.
- It is necessary in the formation of fruits and seeds.
- It is needed for cell division
- Production of fats and proteins.
- It helps in nitrogen break-down during respiration
- It is a constituent of nucleic acid (DNA, RNA)
- It is important in the synthesis of nucleoprotein
- It is a constituent of phospholipids.
- It gives resistance to certain diseases in crops.
- Its essential part of all the sugar phosphate in photosynthesis and other metabolic processes.
- Improves the quality of crops more especially vegetables.

DEFFICIENCY SYMPTOMS

- Purple colouration of the leaf especially at the margin.
- Low yield of grains, fruit and root crops
- Slow growth rate resulting into late maturity of the crops.
- Red necrotic areas on the leaves, petioles etc.
- Distortion of the leaf shape
- Older leaves become dark brown.
- There is a general overall stunted ness and leaf fall.

POTASSIUM

Importance

- It increases resistance to certain diseases
- It encourages root development and growth
- It is necessary for formation of starch and transport of sugar within the plant.
- It is essential for chlorophyll formation.
- It is needed in nitrogen metabolism and protein synthesis.
- It reduces lodging in plants by strengthening cellulose cell wall.
- It controls stomatal movement hence loss of water.
- Its important to folic metabolism
- It has been linked with carbohydrates metabolism.
- It regulates water in plant cells.

Deficiency symptom

- Retarded root development
- Plants are easily attacked by diseases

- Leaves dry out at the edges
- Premature loss of leaves
- Chlorosis can also be experienced
- In cereals cell at the leaf tip and margin die first.
-

Factors affecting the availability of potassium in the soil

Soil moisture: Too much moisture interferes with exchangeable moisture.

Soil pH: High soil pH favours potassium fixation

Temperature: High temperature favours the level of exchangeable potassium

Types of colloids: Potassium fixation is usually done in soil containing montimolironite.

CALCIUM

Importance

- Raises soil pH which favours nitrogen fixing bacteria
- Improves root development and growth
- It improves vigor and stiffness of the stem,
- It governs the availability of certain essential minerals like phosphorus and potassium.
- It is an activator of enzymes in plants
- It is associated with cell wall structure
- In increases carbohydrates content in crops like cotton.
- It increases the number of mitochondria in wheat plants.
- It protects plants from injuries due to the effect of hydrogen ions.

Deficiency symptoms

- The roots become stunted
- Death of the leaves occurs
- Formation of weak stem
- Leaves become chlorotic and chlorosis occurs along the margin of younger leaves.
- Terminal buds and tips of roots do not grow well
- There is distortion of the growing shoot tip
- Cell walls become rigid and brittle

Sources:

- Crop residues
- Manure i.e. organic and inorganic
- Weathering of sol minerals
- Agricultural lime

MAGNESIUM

Importance

- It is a constituent of chlorophyll hence responsible for the green colour.
- It is important in the formation of oils in plants.
- It encourages the production and transportation of carbohydrates and proteins in growing plants.
- It maintains the integrity of chromatic fiber and ribosomes.
- It is necessary for full activity of two principle carbon dioxide fixing enzymes.

Signs of magnesium deficiency.

- Loss of green colour in leaves
- Development of purple, orange, and red patches in horticulture crops such as cabbages.
- It causes extensive chlorenchyma development and scanty pith formation.

SULPHUR

Importance

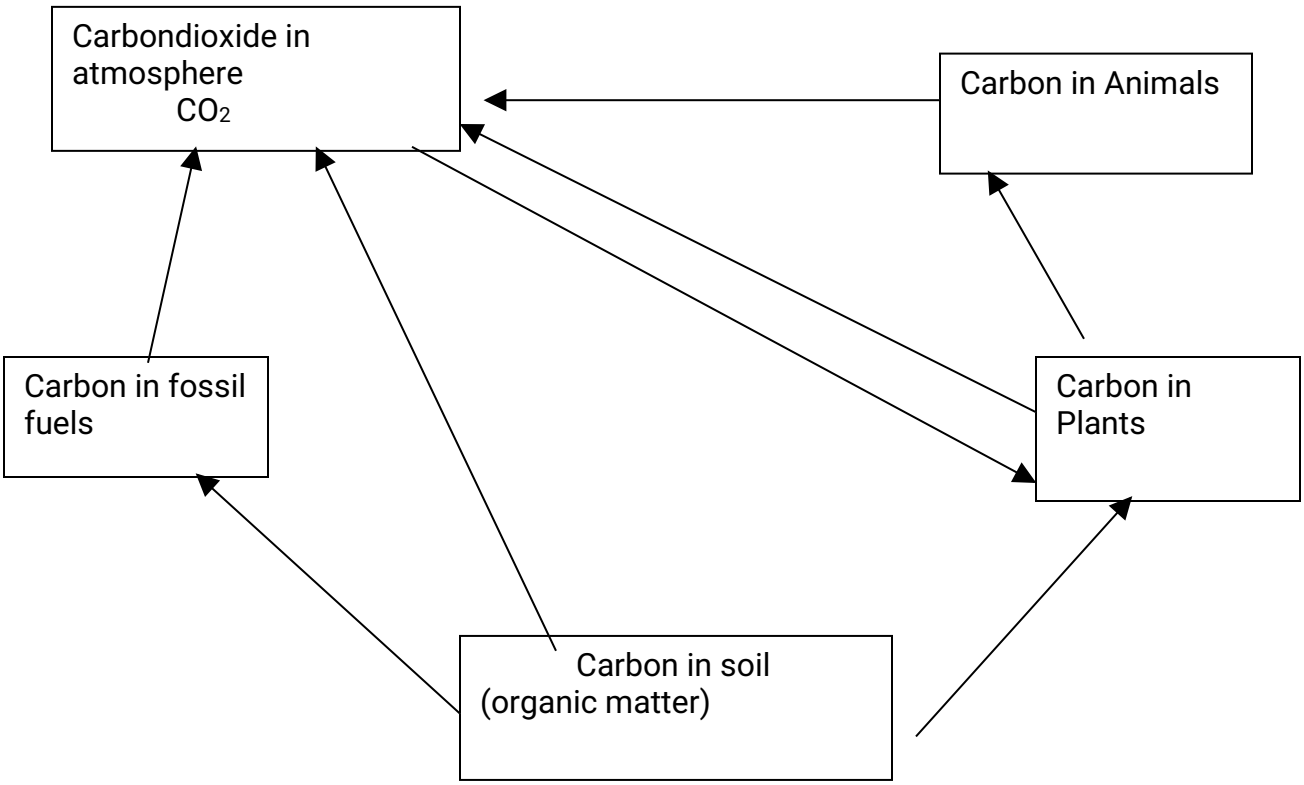
- It is needed in protein synthesis as it's a component of some amino acids.
- It is used in the production and activation of some enzymes.
- It increases the oil content of crops (plants)
- It is essential in the production (formation) of some vitamins like biotine.
- Sulphur together with iron form enzymes important in photosynthesis, respiration, and nitrogen metabolism.

Deficiency symptom

- Lack of root nodules in legumes.
- Stems are thin and plants are extremely small and short.
- There is complete chlorosis
- There is rapid leaf fall
- Leaf tips and margins are rolled inwards.
- Terminal bud growth is inhibited and lateral buds develop pre-maturely.

NITROGEN CYCLE

CARBON CYCLE



MANURES AND FERTILIZERS

These are substances which are either organic or inorganic that add fertility to the soil once applied.

There are two types of manures /fertilizers i.e. organic manures and inorganic manures.

Inorganic manures/fertilizers are chemical substances which are manufactured artificially to supply the chemical elements required for growth and reproduction of the plant.

ORGANIC MANURES

These are substances derived from plants or animals products that will add fertility to the soil once applied.

Examples of organic manures:-

Farm yard manure, livestock manure or muck
Green manure
Compost manure

Importance of organic manures:

- They increase nitrogen content in soils after decomposition
- They increase the availability of plant nutrients like potassium, calcium, magnesium, and phosphorus.
- They increase the humus content in the soil after their decomposition.
- They improve the soil structure more especially in sandy soils.
- It increases the population of microbes in the soil by acting as food for such living organisms.
- Organic manures like muck can rise the soil PH
- They do not have residual effect on the soil.
- Deactivates organic pesticides
- Increases cation exchange capacity of the soil

Characteristics of organic manures

i. They are derived from plant and animal materials
ii. Contain much lower amounts of plant nutrients
iii. They improve soil structure
iv. They stimulate the rate of microbial activities
v. They are more costly to apply per unit of per unit of plant food
vi. They are not leached easily due their low solubility in water
vii. Have no residual effects on crops and soil organisms

COMPOST MANURE:

This is a mixture of decomposed crop remains, vegetable matter, weeds and kitchen refuse.

Advantages of compost manure:

- It really releases nutrients for plant growth.
- It promotes the conservation of soil moisture by lowering the rate of evaporation of water from the soil.
- Fully mature compost manure is black therefore helps in absorbing the sun's heat.
- It improves on soil structure more especially in sandy soils.
- It promotes the activity of microbes in the soil by providing food for them.

- It enhances the creation of neutral reaction in the soil.

Limitations of compost (disadvantages)

- If used immediately after making, it can heat up and burn crop roots.
- It requires a lot of Labour to prepare it.
- Big volumes of compost are needed to be applied in order to obtain the required nutrients.
- There should be a good source of composting materials in order for a framer to make enough which is not always easy.
- It requires large volumes of water during processing to keep the temperatures at optimum.

METHODS OF COMPOSTING

There are two main methods i.e. Heap method and pit method.

PIT METHOD

This is when composting is done in pits dug in the ground. It is mainly applied in areas with low rainfall.

Procedure of making compost

i. Pits measuring up to 180cm in length, 120cm width and 60cm in depth varying according to the type of materials being used.

ii. Stones/ maize stalks are placed at the bottom of the pit to form a foundation and promote proper air circulation

iii. Materials for composting should be chopped into small pieces

iv. Composting materials should be arranged in the pit as follows; maize stalks/ elephant grass at the bottom 10 cm height, grass/ leaves/ weeds/ kitchen refuse 10cm height, manure(farm yard) 10cm height, wood ash 10cm height and top soil 10cm height in order.

v. Repeat the arrangement until the pit is full

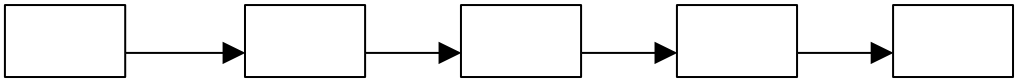
vi. Put plant leaves at the top of the pit to facilitate proper air circulation

vii. Add about 0.5 kg of ammonium Sulphate at any 0.3m height to increase nitrogen content of the compost manure.

viii. Place a stick long enough to reach to reach the bottom to monitor the temperatures

ix. Sprinkle water to the pit when the temperatures are high to maintain it at optimum

x. Turning of the material in pits should be done every after 2 to 3 weeks to enhance complete decomposition as follows;



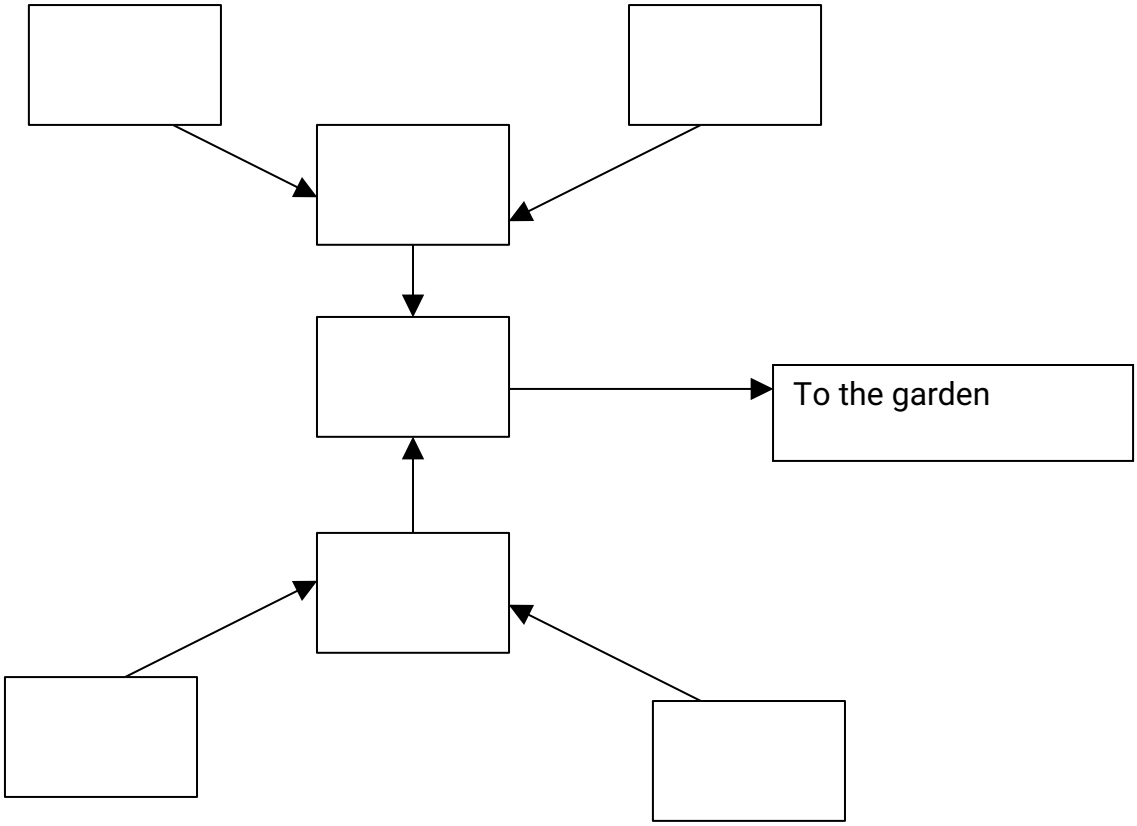
xi. Materials in pit A are put in pit B and pit A filled with fresh materials
xii. After 2 to 3 weeks materials in B is turned to pit C and replaced with that in pit A
xiii. Materials are changed every after 2 to 3 weeks in the order until there is complete decomposition
xiv. This type of sequence ensures continuous supply of manure to the garden

Heap/ stack method

This is done in areas with high rain fall

Procedure of making compost

i. Select a flat area with a good drainage
ii. Make stacks/ heaps of about 1.5 to 2 m squared and 1 m away from each other.
iii. Materials for composting should be chopped into small pieces
iv. Composting materials should be arranged in the pit as follows; maize stalks/ elephant grass at the bottom 10 cm height, grass/ leaves/ weeds/ kitchen refuse 10cm height, manure(farm yard) 10cm height, wood ash 10cm height and top soil 10cm height in order.
v. Repeat the arrangement until the heap/ stack is full
vi. Put plant leaves at the top of the heap/ stack to facilitate proper air circulation
vii. Add about 0.5 kg of ammonium Sulphate at any 0.3m height to increase nitrogen content of the compost manure.
viii. Place a stick long enough to reach to reach the bottom to monitor the temperatures
ix. Sprinkle water to the heap/ stack when the temperatures are high to maintain it at optimum
x. Turning of the material in heaps should be done every after 2 to 3 weeks to enhance complete decomposition as follows;



xi. Turn compost material in stack 1 to an empty stack A and that in stack 2 on top of 1 in A after 3 weeks.
xii. Turn compost material in stack 3 to an empty stack C and that in stack 4 on top of 3 in C after 3 weeks.
xiii. Empty stacks should be refilled with fresh composting material to ensure continuous supply of compost on the farm.
xiv. Turn material in stack A into stack B then followed by that from C after about 7 days
xv. Leave the materials in stack B until decomposition is complete

Precautions to take when preparing compost manure

i. Make stacks/ heaps that are neither too small nor too big to avoid incomplete decomposition
ii. Ensure free air supply to the compost container for proper decomposition
iii. Avoid putting sticks and plastics in compost materials since they reduce quality

iv. Sprinkle enough water to maintain temperature good for proper decomposition
v. Occasionally turn the materials to ensure proper decomposition
vi. Add thin layers of farm yard manure to improve the quality of compost manure
vii. Do not trap flies in compost material during composting since it may lower quality
viii. Place compost pit or heaps in areas sheltered from sun's heat and wind.

GREEN MANURE

This is the manure made by incorporating green and vigorously growing plants into the soil.

X-teristics of a good green manure plant:-

- It should be able to grow very fast so as to meet the required purpose in time.
- It should have high nitrogen content.
- It should be leafy or highly vegetative.
- It should be able to rot rapidly and provide manure.
- It should be disease and pest free.
- It should be easy to plough into the soil.

Advantages of green manure:

- It supplies Organic matter to the soil which can improve soil structure.
- It adds nitrogen to the soil especially when legumes are used.
- It stimulates bio-chemical activities in the soil
- It assists in conserving and making available plant nutrients.
- It increases yields more especially in maize, by 20% -70%.

Limitations of using green manure:

- Potential crops for green manure are food crops therefore its difficult to convince farmers to practice it that way.
- Machinery is needed to incorporate the plant into the soil which may not be readily available.
- Old plants with high fiber content are very difficult to plough into the soil.
- If the crops are left to grow until they are hard and fibrous, they may not decompose easily.

FARM YARD MANURE (MUCK, LIVESTOCK MANURE)

This is manure consisting of fermented dung and urine of animals mixed with rotten vegetable matter.

Importance of farm yard manure:

- It adds large quantities of organic matter to the soil.
- It provides the soil with essential nutrients like NPK (Nitrogen, Phosphorus & Potassium).
- It can be used to improve the quality of other organic manures such as compost.

Preparation of farm yard manure

- Place dry litter in the animals' pen to act as bedding
- Turn the litter as animals defecate and urinate on it
- Select a flat place with a concrete floor out side the pen
- Remove the dirty litter from the pen and place it on the concrete floor
- Raise a shade over the litter collected from the pen to protect it from rain and sun shine
- Allow the contents to decompose completely while in the shade
- Coat the content with a thin layer of top soil to reduce loss of nitrogen
- After six weeks the manure is ready for use

N.B Farm yard manure should be prepared under cover to prevent losses of nitrogen and soluble mineral nutrients.

Factors affecting the quality of farm yard manure:-

1. The type of animals that provides dung; Non ruminants and fattening animals produce dung rich in nutrients than that of lactating animals which extract a lot of phosphorous from the feeds.
2. Type of food the animal eats; Feeds that are rich proteins and minerals tend to produce better quality dung for manure.
3. The type of beddings (litter) used by the animals; Cereal straw has a higher capacity of absorbing moisture therefore can make a better raw-material for manure.
4. Method of storage: Manure heaps should be sheltered from direct sunshine and rain since rain leaches away nutrients.
5. Length of time given for complete decomposition; The more time given for complete decomposition, the higher the quality of the manure.

INORGANIC FERTILIZERS

These are chemical substances which are manufactured artificially to supply the

chemical elements required for growth and reproductive ness of plants.

TYPES OF INORGANIC FERTILIZERS

There are two main types of inorganic fertilizers

i. Straight fertilizers
ii. Mixed /Compound fertilizers.

STRAIGHT FERTILIZERS

These supply only one of the primary macro nutrients (nitrogen, phosphorus and potassium) e.g urea, single super phosphate, double super phosphate, Sulphate of ammonia, calcium-ammonium nitrate and ammonium nitrate.

MIXED/ COMPOUND FERTILIZERS

These contain atleast two of the primary macro-nutrients (elements) of Nitrogen, Phosphorous and Potassium (NPK). Examples of such fertilizers are N.P.K., Di-ammonium phosphate, ammonium hydrogen phosphate etc.

Advantages of Compound Fertilizers

The mixture is usually dried into fine and well-mixed granules which can be applied by hand and through fertilizer drill.

The mixture is stable and does not cake up to form lamps

They contain all the major plant nutrients in right proportions.

They save the farmer's Labour of mixing fertilizers during application.

Disadvantages (Limitations)

They are slightly more expensive than straight manures.

They may be unsuitable for most of the soils which lack only one nutrient.

FACTORS INFLUENCING (DETERMINING) THE USE OF MANURES BY FARMERS:

- Soil analysis: This is important because it expresses the need and type of fertilizers
- The types of fertilizers available; Different crops require specific nutrients and therefore the fertilizers available in shops should meet the above.
- Price of a fertilizer, increases use of fertilizers by farmers is determined by the prices and the expected profits after use.
- Management; The farmer's follow-up of the right application method and period of application affects the results achieved after use.
- Knowledge and skills of the farmer; Farmers more informed about fertilizers can use more of it
- Crop value; growing low value crops may not encourage the use of fertilizers since the cost may be higher than the yield expected

FACTORS AFFECTING CROP RESPONSE TO FERTILIZERS

. Nature of fertilizers; Highly soluble fertilizers can be easily absorbed and used by crops
ii. Soil factors; Some soils have a higher ability of supplying nutrients than others and it varies from place to place and time to time
iii. Climate; Places with low rainfall have reduced leaching hence most of the fertilizers applied will be used by crops
iv. The rate of application; Some fertilizers once applied in excess will become toxic and hence not used by the crops or cause death to the crops
v. Crop factor; Some crop will fail to respond to a particular fertilizer hence making it useless crops will need a higher quantity of the fertilizers to respond.
vi. Crop age ; Mature crops may have low fertilizer requirement than the young vigorously growing crops
. Presence of pests and diseases; Crops attacked by such shoe a low response to, fertilizers due to a compromised crop physiology
viii. Weed population; A high population of weed in the garden will use a lot of nutrients leaving little for the crop hence low crop response
. Soil structure; Poor structure prevents proper root development hence a reduced nutrient absorptive power for crop roots.

APPLICATION OF FERTILIZERS TO THE SOIL:

The methods for supplying fertilizers efficiently are:-

1. **Broadcasting** before planting: Here the fertilizer is spread uniformly over the field and it gives positive results for seeds which are broadcasted.
2. **Row or band placement**; In this method, the fertilizers are placed in localized areas along the rows at calculated distance for maximum absorption by plants.
3. **Top dressing;** The fertilizers more especially nitrogenous is applied as a second dose by broadcasting on the soil surface close to the plants when the crop is 3-4 weeks old.
4. **Drill placement**; The fertilizers is applied by a drill along with the seed during planting. The method gives good results with wheat, maize and other cereals.
5. **Band placement;** The fertilizer is placed on one side or both sides of the row about 5cm below the seed and 4cm from the plant. The method is useful for crops which are sensitive to direct contact with fertilizers like cotton and tomatoes,
6. **Application by plough**: The fertilizers are placed in a continuous band at the bottom of the plough furrows. Each band is covered as the succeeding furrows are turned over.
7. **Applying liquid fertilizers by irrigation or spraying**: The application of fertilizers in solution can be used on high value crops and the fertilizer has to be soluble in water.

SOIL AND WATER CONSERVATION

This is the science and art of looking after the land in such a way that soil is retained in one place and not carried away by erosive agents.

Aims of soil and water conservation:

- To reduce soil losses by taking measures against agents that cause soil erosion.
- To maintain soil fertility that can be lost through erosion.
- To retain water essential for crop growth.
- To maintain the physical properties of soil that is ideal for crop production.

SOIL EROSION

This is the removal /washing away of top soil by wind and running water.

Factors predisposing soil to erosion:-

1. Overgrazing: Keeping a high number of grazing animals on a limited amount of pasture removes vegetation cover exposing land to erosion.
2. Burning of vegetation: this removes the vegetation from the soil exposing it to erosive agents like water and wind.
3. Over cultivation: This reduces the organic matter in the soil and also destroys soil structure making the soil more prone to erosion by running water and wind.
4. Improper farming methods: Like ploughing along the slope, planting annual crops on steep slopes encourages soil erosion.
5. Man's activities: The major activities here are those involved in construction which can lead to the clearing of vegetation.

Effects of Soil Erosion in Agriculture:

1. It reduces the quality of soil by washing away soil nutrients and increasing acidity.
2. There is a reduction of land area available for production more especially where gully erosion occurs.
3. Erosion increases the costs of production since the farmer will spend money trying to control it.
4. It destabilizes soil profiles by transferring soil from one place to another.
5. Erosion leaves the soil surface bare and hard which makes the soil more difficult to work.
6. Soil productivity is reduced more especially when less productive soil is deposited over the productive soil.
7. Gully erosion in particular makes mechanization on the affected field very difficult.
8. Erosion can lead to water pollution more especially where fertilizers from land are washed into water bodies to cause pollution of the water.
9. Erosion leads to the sedimentation of dams, rivers, and lakes.
10. Leads to spread of weed seeds.

11. It may lead to the spread of pests and diseases in gardens
12. It alters soil structure and texture that affects crop growth

TYPES OF EROSION:

Geological Erosion: This takes place under natural conditions before man's disturbance of soil and vegetation.

Accelerated Erosion: This is the deterioration and loss of soil as a result of human or animal activities which losses soil directly or indirectly.

Splash / rain drop erosion; this as a result of the impact of rain drops on the soil surface. The seriousness of this erosion depends on rain drop size, vegetative cover, soil structure and land gradient.

Sheet erosion; this is a uniform removal of layers of soil from sloping land as a result of sheet flow. It is the most serious erosion since it removes the most productive layer of soil. It gives way to rill erosion.

Rill erosion; soil is removed leading to the formation of small and clearly cut channels. Rills are small and can be removed by normal ploughing or harrowing

Gully erosion; this is where U and V shaped large channels are formed that can carry a lot of water and soil. Gullies cannot be removed by normal cultivation methods due to their size.

Wind erosion; this is where wind carries soil as it blows over the bare soil surface with no vegetation. It is more serious in places with limited vegetation and loose soil structure

Factors influencing soil erosion:

1. Rainfall intensity: Rain received in small amounts over a long period of time caused less erosion than that received in large amounts for a short time.
2. Topography: the steeper the slope, the faster the speed of water flowing over it and the greater the soil eroded. A longer slope has more water flowing over it and therefore a greater chance of erosion taking place.
3. Vegetation:
   - The density of vegetation cover affects the rate of erosion. Dense vegetation reduces soil erosion by slowing down the speed of rain water and the impact of rain drops on the soil surface.
   - The plant roots can bind soil particles reducing the chances of erosion
   - Decomposed plants add organic matter to the soil which improves the water holding capacity and soil structure that can resist erosion
   - Trees can act as wind brakes hence reducing the effect of wind erosion.
   - Vegetation increases water infiltration which reduces surface run off

4. Farming practices: Continuous cultivation of land leads to the break done of the soil structure making the soil more susptible to erosion.

5. Ploughing down the slope will increase soil erosion since the speed up the speed of water.
6. Man's activities. Disturbance of soil structure and other properties by man may increase rate of erosion

CULTURAL METHODS OF SOIL AND WATER CONSERVATION

I. **Minimum tillage:** this safe guard against disturbance of soil physical properties thus reducing the chances of erosion and moisture loss.

Importance of minimum tillage on soil conservation

Preservers soil structure hence making soil resistant to erosion and water loss.
Reduces loss of water by evaporation.
Conserves organic matter in the soil by reducing oxidation.

II. **Mulching:** This reduces the impact of rain drops on the soil surface to cause splash erosion and also controls loss of soil moisture **Mulch** is any material used to cover the soil surface to prevent excess loss of water by evaporation, control of soil erosion and suppressing weeds.

Materials used as mulch include:-

Straws, dry leaves, trash, stalks, coffee husks, dry grass, sisal waste and polythene.

Advantages of Mulching:

- Reduces soil erosion by checking the speed of water and battering effect of rain drops on the soil surface.
- It conserves soil moisture by reducing evaporation of water from the soil surface.
- It increases water infiltration (down ward entry of water into the soil) by reducing surface runoff.
- Organic mulches decompose and add organic matter to the soil hence improving soil fertility and water holding capacity.
- Mulches moderate soil temperatures hence allowing soil microbes to stay in the soil and carry out decomposition so as to improve soil fertility
- Controls weeds by cutting off light supply to them at seedling stage.
- It improves on soil structure when the organic mulches decompose to provide organic matter.
- It increases yields in certain crops by providing manure and a weed free environment.
- Mulches can control certain pests like the banana weevils (***Cosmopolites sordidus***) which are trapped in the mulch.

Disadvantages:

- Mulches more especially the organic ones can be it when dry and destroy the crops in the garden.

- They can act as breeding grounds for pests like termites.
- Some mulches cause deficiency into the soil.
- Mulching materials are quite expensive for the farmers to purchase, transport, and lay in the garden.
- The vegetable material may be a source of weeds more especially when it is not completely dry.

III. **Crop rotation:** This is the system of growing different crops on the same piece of land in a sequence or definite order so as to preserve and maintain soil fertility.
IV. **Manuring**: Manures improve the soil structure thereby allowing water infiltration and binding of the soil particles together.
V. **A forestation**: Trees planted reduce soil erosion by wind and water since they increase water infiltration into the soil and bund soil particles together.
VI. **Wind breaks**: These are lines of trees planted perpendicular to the direction of the prevailing winds. They reduce the speed of the wind hence controlling erosion by wind.
VII. **Planting cover crops**: This are crops planted to reduce the rate of water runoff from the soil surface and holds the soil particles.

X-teristics of a good cover crop:

- It should be easy to establish and multiply
- It should grow rapidly and vigorously to suppress weeds
- It should not act as a competitor to the main crop.
- It should not demand too much Labour to control its growth.
- It should be tolerant to pruning and slashing
- It should strive well on a fertile soil
- It should be resistant to pests and diseases.
- It should have good forage which spreads over the soil
- It should be able to withstand sunlight during the early stages of growth.
- It should be able to tolerate shading by the main crop.
- It should be drought resistant so as to be able to survive long drought.
- It should not produce any substance that has toxic effect to the main crop.
- It should be easy to be removed when necessary and incorporated into the soil.

VIII. **Strip cropping**: Here crops and pastures are planted along the contours in alternate strips to reduce soil erosion by slowing down the speed of running water.

IX. **Intercropping:** When cereals are intercropped with legumes having broad leaves, soil erosion, can be reduced by the broad leaved plant.

MECHANICAL/PHYSICAL METHODS OF EROSION CONTROL

Terracing: This is done in places with steep slopes where terrace are constructed to reduce the slope. The terraces can be of various forms like broad based terraces, narrow terraces and bench terraces. These reduce the speed of running water down the slope and encourage water infiltration.

Contour ploughing: This involves ploughing across the hill along the contours to reduce the extent of water run off over the surface of the soil by the help of furrows.

Bunds These are heaps of soil made across the slope to trap any water that flows down the hill to conserve soil

Ridges. These are the heaps of soil that are made across a slope on which crops are grown. They trap soil and water running down the slope

Gabions/barrages. These are obstructions/structures of stones mainly put in trenches to reduce the speed of water down the trench and trap any soil in the water flowing

Diversion channels. They are water channels constructed at the raised part of the field to divert water flowing down into the garden

Deep ploughing. Ploughing down to the subsoil increases water infiltration and hence reducing surface run off. This controls soil erosion

Graded banks. Water runoff in the garden is reduced by construction of banks and reducing of the slope. Water from each bank is conducted away

Absorption banks. These are channels constructed across the slope of the field to trap rain water for future use.

Grassed water ways. These drainage channels which lead away excess water and having grass planted in them to trap soil and reduce water speed

LAND RECLAIMATION

This is the practice of regaining or bringing back waste land to use so for cropping, rearing animals or settlement. Such land could be under swamps, rivers, forests, deserts of infested with pests like tsetse flies.

Methods of Reclaiming land:

These include the following:-

Deforestation, irrigation, terracing, draining swampy areas, afforestration, application of fertilizers, land clearing, pest control, leveling and stumping.

Deforestation: Here forests are cleared using bulldozers, motorized saws, axes or panga to release land for agriculture. However this practice has other negative effects on the environment.

Draining swampy areas: Land drainage is a method of rehabilitating land by removing excess water from an area which is water logged.

Advantages of draining land:

- Drainages provide a good environment which encourages optimum root growth by improving aeration.
- Drainage raises soil temperatures since a wet soil is usually cold. This improves the growth of plants since they need warmth around the roots.
- Drainage allows tractors and other machines to move easily over the soil.
- It is important in controlling parasites like the liver flukes
- Drainage improves on the soil structure of a particular place.
- It creates a water table which does not fluctuate much good for citrus fruits.
- It improves root penetration into the soil hence proper growth of the plant.
- Crop losses during harvest which are due to wet conditions are minimized by draining land.

METHODS OF DRAINING LAND

The methods that can be used include:

Surface drainage: This is the removal of water from the surface of the soil by means of open ditches. Open ditches are used to remove excess (surface) water from low laying areas:-

Advantages of surface drainage

- It is easy to notice the blockages and therefore corrected easily.
- Open ditches are cheap to construct
- There are less chances of leaching in this method
- Does not dry out the soil completely hence preserving soil moisture

Disadvantages

- They are more prone to gully erosion which may be destructive.
- The ditches occupy good land which could have been used for crop growing.
- They interfere with mechanical tillage operation and livestock improvement.
- They are expensive to maintain
- Leveling should be done before water can flow into the drains which may be difficult to achieve

SUB-SURFACE (UNDER GROUND) DRAINAGE / TILE METHOD

This is where water is drained away from water logged areas through tiles or drain pipes laid under ground:-

Advantages of tile method (sub-surface drainage)

- It leaves the field free of surface obstruction
- It does not encourage gully erosion as observed in surface drainage.
- There is no need to level land to facilitate drainage.

Disadvantages of the tile method:

- May lead to excessive leaching in areas with heavy rainfall

- They dry out the land excessively at times and yet be in adequate during wet weather.
- They are expensive and require skilled Labour to install.
- They are easily blocked by roots of many perennial crops

Sub-soiling drainage.

This is the removal of surface water logging caused by the build up of an impervious layer using a heavy cultivation with one or more times that can penetrate up to 90cm deep. The operation cracks and loosens sub soil especially under fairly dry conditions.

Use of deep rooted plants

Plants like eucalyptuses which have deep rooted that can penetrate impervious sub soil can be used in draining land.

Terracing:

This conserves water and soil making the field easy to work with machinery. It is mainly done in hilly places.

Afforestration:

This is practice of planting trees in places where they died out or where they have never existed before. Trees are planted in areas such as hilltops or on slopes of mountains and hills, where no crops can grow.

Leveling:

This is done in places with anti-hills which hinder mechanization. The place is leveled to allow machinery use and crop production.

Land clearing:

This is carried out in order to meet the following objectives:

- To increase land for crop and animal production
- To make mechanization possible
- To discourage pests.

It can be done using hand method, mechanical method, chemical method, bush burning or use of explosives.

Fertilizers application:

This is done in order to reclaim poor soil more especially for crops production. Inorganic fertilizers can be added to improve the fertility of such an area.

Pest control:

Since pests are a problem since they are vectors of important diseases like sleeping sickness in humans and nagana in cattle for tsetse flies. Places with such pests should be sprayed to allow human settlement and agricultural production.

Stumping:

This is the removal of tree stumps from an area. It eases mechanization and provides more area for agricultural production.

Irrigation:

This is the practice of applying water artificially to the soil in areas where there is no rain or where rain is inadequate.

TYPES OF IRRIGATION

1. Surface irrigation

This is the application of water over the surface of land. It may include the following methods:

Flood irrigation	furrow irrigation
Border irrigation	basin irrigation

a. Flood irrigation:

In this method, water is applied by flooding flat areas. It is the most suitable areas in places with abundant and cheap water.

Advantages

Flooding can kill crop pests and diseases

It does not need the leveling of land.

Good for areas with abundant water supply

Disadvantages:

If the water flows fast, it may not infiltrate the soil.
Water logging and leaching of nutrients may occur
Surface runoff may cause soil erosion.
Little control of water supplied leads to wastage.
Excess water causes leaching

b. Furrow irrigation

Here water is supplied to rigid land from a main source through supply canals. The excess water collected from the bottom of the field in drains which lead to a water way.

N.B. Crops are normally grown on ridges which must be carefully panned.

Advantages

Water infiltrates uniformly

This method is suitable for row crops such as cereals since furrows can be made in a row form

Can use poor quality water since there are no pipes to be blocked

Disadvantages

There is a danger of salt accumulation in the furrow more especially if the water contains salts.

It may encourage soil erosion

Excess water may cause leaching

Movement in the garden by machines is impeded

May require grading of land which increases costs of production

Sometimes enough water does not reach the end of the furrows.

c. Border irrigation

In this method water from the supply canal is applied to the top end of strips of land which are divided by low earth bunds. Due to even grading of the land, the water flows in a regular uniform sheet down each strip wetting the soil as it advances.

d. Basin irrigation

This is a system used on leveled land to irrigate orchards mainly. A basin is made either for each tree or group of trees depending on the soil conditions and surface slope.

The advantages of this system are that the Labour cost is low and it uses less water.

2. Over head / sprinkler irrigation:

This involves supplying water just like natural rain. The system consists of a pumping unit which supplies water under pressure and it is sprinkled to the crops and soil.

Advantages

- Water delivery can be matched with crop requirements.
- Movement in the garden by machine is not affected.
- It does not require the leveling of land hence reduce the costs involved in that.
- It does not encourage soil erosion as observed in the surface methods of irrigation
- Agricultural chemicals such as fertilizers pesticides and herbicides can be applied uniformly with the irrigation water.

- Adapts to dry topography.
- The system does not require special skills to operate it as seen in drip irrigation.
- Can be integrated with several agronomic practices in the garden.
- It is an idea method in sandy soils and hilly areas
- Low maintenance costs.
- There is adequate infiltration of water into the soil which is important in crop nutrients absorption.
- Sometimes the high pressures of water from the irrigation system can kill pests.

Disadvantages:

1. The water droplets may have a hardening effect on the soil which hinders further water infiltration.
2. The system requires a high initial capital to install which may not afforded by the peasants.
3. Water does not tend to infiltrate very far into the soil more especially when pumped in small amounts.
4. There is a risk of salt accumulation around the root zone areas.
5. If the weather is windy, the application of water becomes uneven.
6. The system has been known as one way in which pathogens are spread in gardens (pathogens are diseases causing organisms)

3. Drip / Trickle Irrigation

This is relatively new method of irrigating crops and is mainly used in the USA, Australia and Israel. Water is supplied through plastic pipes to each row of crop plants and a small nozzle allows water to trickle out and provides moisture around the plant roots.

Advantages

- Water is delivered near the root area so that the crops the crops can get a good supply of water.
- There is less chances of water evaporation and accumulation of salts as in overhead and surface irrigation.
- The area between the rows in not invaded by weeds since there is no water supplied there.
- It is a very economical way of using water since it involves less wastage.
- Fertilizers can be mixed in the water and supplied to the crops.
- Low pressure is required to pump the water through the system hence saving energy intake.

Disadvantages

- It requires a high initial capital to purchase and install the requirement in ths type of irrigation.
- The system requires good quality water which can not block the pipes.
- It is unsuitable for steep and uneven areas

FACTORS THAT DETERMINE THE TYPE OF IRRIGATION TO BE USED IN AN AREA:

1. The source of power

Abundant power supply in an area can encourage some body to use overhead irrigation since there is power to pump the water.

2. Type of soil

Loose sandy soils are not good for the surface methods of irrigation since they are more prone to erosion. But over head irrigation can be good in such places.

3. Topography

An area with hills and valleys can only allow overhead irrigation which doesn't involve the leveling of land.

4. Type of crops grown.

The growing of high value crops can allow the use of costly irrigation methods like drip and sprinkler irrigation methods since a farmer will be able to cover the costs.

5. Methods of planting crops

Crops planted in row can allow the use of drip irrigation method and most of the surface methods which can't be used in broadcasted crops.

6. Availability of water.

Places with limited water supply can efficiently apply drip irrigation method since it is more economical in the use of water.

7. Capital

The availability of enough capital will allow a farmer select any type of irrigation methods since he can afford all the costs involved.

8. Knowledge and skills

Some methods of irrigation like drip require special skills and knowledge which must be readily available during installation and maintaining

9. Climatical records:

These will show the natural water available to the crop in order to determine artificial application needed in a particular period.

CROP PRODUCTION

FACTORS THAT DETERMINE / AFFECT CROPS GROWN IN AN AREA.

The factors are divided into two broad group's i.e.

- Abiotic factors
- Biotic factors.

ABIOTIC FACTORS

These are factors that are a result of non living part of the environment e.g

Soil fertility *Soil density*

Soil texture *Quality and quantity of light*

Humidity *temperature*

Rainfall *wind*

Day length

1. Soil PH

Different crops require different specific pH for their proper growth e.g. tea require acidic soil, tobacco may require slightly acidic soil.

2. Soil fertility

Crops are nutrients which must be readily available for their proper growth.

3. Soil drainage.

Some crops like rice are able to thrive in poorly drain soil while others like maize cannot withstand poor drainage.

4. Soil structure

This affects the movement of air, transfer of heat and root development.

5. Soil texture

This can also affect the number of physical properties of soil which are very crucial to crop growth.

6. Temperature

Some plants like the cereals and grases can live in area with high temperature. Since they are the mechanism of closing their stomata durig the day.

7. Availability of water.

Water is used as a raw material for photosynthesis. Absence of water in a particular area can limit the growth of a particular crops more especially these that are not drought resistant in bananas.

8. Topography

This determines the number of factors like temp, humidity rainfall which all affects crop growth.

9. Pest and diseases.

Crops in some areas have been eliminated due to the presence pest and diseases.

e.g. Tomato growing in most areas of Uganda is limited by bacterial wilt.

10. **Wind**.
    At high attitudes strong winds are experienced which will affect the growth of crops.

11. **Social factors**
    Some communities are growing certain crops since historically they have acted as food crop e.g. millet among the Itesot of Uganda.

12. **Economic reasons**
    Some crops are cash crops therefore they must be grown to provide farms with income e.g coffee, tea, cocoa.

13. **Government policy.**
    The government has been restricting the growth of certain crops for health reasons and security e.g. Opium / Marijuana.

CLASSIFICATION OF CROPS;

Crops are classified into two main groups

a) Annual crops
b) Perennial crops

ANNUAL CROPS

These are crops which complete their life cycle within one year e.g.

i. Cereal (millet, Sorghum, Rice, Wheat, Barley, Maize, Oats, and Rye)
ii. Legumes (Beans, Soybeans, Cowpeas, Pigeon peg, G-nuts)
iii. Root Crops (Cassava, Sweet potatoes, Irish potatoes, Yams,)
iv. Vegetables (cabbages, tomatoes, onions, egg plants, amaranthus spp, carrots, dodo, spinach, pumpkins, cucumber, water, melon, garlic, pepper.)
v. Oil crops (Simsim, sunflower, cotton)
vi. Fiber crops ((cotton)
vii. Drug crops (Pyrethrum)

PERRENIAL CROPS

i. Beverages; coffee, tea, and cocoa
ii. Fruits; pawpaw, guava, avocado, jack fruit, passion fruit, pineapples, bananas,e.t.c

iii. Citrus; oranges, lemons, tangerines, e.t.c.

iv. Sugar crops; sugar cane and sugar beet

v. Spices; vanilla, ginger, clover, e.t.c.

CEREALS

These are commonly known as grain crops and they have a high content of carbohydrates. They are the most common food crops used all over the world.

REASONS WHY CEREALS ARE THE MOST FOOD USED IN THE WORLD.

1. They are easy to prepare as food for example rice and posho.
2. They are adapted to a very wide range of soil and the environmental condition.
3. They have fewer pest and disease as compared to other crops.
4. Cereals contain a high amount of carbohydrates and vitamin which are highly needed in our diet.
5. Because they contain low moisture content they are easy to store and used when needed.
6. Cereals have a short life cycle as compared to the crops and other perennials.
7. Cereals can be used as food for both man and animals.
8. Because they are less bulky hence it is easier to transport cereals from one place to another.
9. Management practices like plant, weeding, can be easily done by machines reducing Labour requirements during production.
10. They do not require special seed bed before being planted.

MAIZE - ZEA MAYS

Plant characteristics

1. Maize is an annual cereal crop which can grow up to a height of 4- 6 metres
2. A mature and a growing maize has a prop root radiating from the main stem outward into the soil providing support. The depth of the root depends on number of factors e.g. soil, rainfall etc.
3. The tassel i.e. male maize inflorescence emerges at the top of the plant and shed its pollen over a period of about one week.
4. The silk i.e. female inflorescence emerges from the ear outwards towards the end of pollen shedding and remains conceptive for a period of about three weeks.
5. In good condition maize leaves are green with parallel vein and long i.e more than 0.5m.
6. At an early stage of growth it can be plough down as green manure to provide nutrient into the soil.
7. Young maize can be used for making hay for feeding livestock however it can bring digestive problem if the maize is a mature one due to fibrous content.
8. Maize flour contain a lot of carbohydrates when eaten it can be metabolized to provide energy to support the organism.

Growth requirements

9. Maize requires a well drained soil with a good supply at nutrient
10. It can not tolerate a slightest degree at water logging.
11. It requires enough rainfall which is equally well distributed but however, during harvesting it should be as compared to during silking where enough water is needed.
12. Maize thrives very well between temperatures of 20 – 25^0 C. High temperature during the day is accompanied by high rate of transpiration and low temperature at night is accompanied by a high rate of respiration thus limiting yield.

Seed bed preparation

13. Seed bed preparation is done by hand roughly this in turn advantageous because weeds are killed, encourage water infiltration and resist soil erosion than in fine seed bed.
14. Secondary cultivation may not be necessary since the crop has big seeds.

Planting and spacing

15. It should be planted at the beginning of the rain because early planted maize benefit from nitrogen flush that occur when a dry soil are wetted and suffers less from fungal diseases
16. Planting is done mechanically by planter or by hand. Two seeds are planted in one hole made at 5cm deep in moist soil but in dry soil should be placed 10cm deep to prevent it germinating as a result of only a slight shower.
17. Spacing should ensure low population Atleast 90 cm X 30 cm between each plant. This is to reduce competition for basic growth requirement. However spacing can be determined by other factors like soil fertility, soil moisture, variety, e.t.c.
18. In properly spaced maize in area of reliable rainfall weed free condition need only to be maintained until the crop is 45cm high. After this height the crop suppresses weeds by itself.

Weeding and fertilizer application

19. Maize is weeded when its between 10 - 15cm and before it starts silking
20. selective herbicides can be used to control weeds like atrazine herbicide
21. Nitrogen fertilizers should be applied as top dressing when maize is at about 45 cm high.
22. Phosphates should be incorporated into the soil at the time of sowing.
23. Farm yard manure can be applied to the soil to increase its fertility owing to maize growth and development.

Pest and disease control

24. Pests that affect maize include stalk borer and army warm which its larvae may eat all the leaves until only remain midrib.
25. Few diseases like white leaf blight, maize streak caused by virus and rust caused by fungus attack the crop.
26.

Harvesting and yields

27. Harvesting maize is done mechanically by combine harvester and manually by hand.
28. Maize grain is physiologically mature at a moisture content of about 35%. when left in the field to dry it is reduced to 19 – 20% after the husks has been removed.
29. Maize is dried and stored in the crib i.e. a store with wall of wire netting.

Question.

Describe the agronomic practices carried out in the growing of rice from planting to harvesting.

- Plant characteristics.
- Ecological requirement of the crop (soil, rainfall, humidity, temp)
- Importance
- Seed bed preparation
- Planting
- Weeding (thinning, pruning)
- Fertilizers application
- Harvesting
- Yield
- Storage.

VEGETABLES

1. They are sources of income when a farmer decides to sell.
2. They are very good source of vitamin like vitamin A and C.
3. They act as appetizers for food e.g. onions and tomatoes.
4. They are a good source of minerals e.g. Iron, magnesium.
5. They heap in controlling digestive problem like constipation
6. They can be used as animal feeds like cabbages to rabbits.
7. Vegetables growing provide employment for people working as attendants in vegetable gardens.
8. Vegetables are a good source of manure since they rot fast.
9. Leguminous vegetables fix nitrogen into the soil e.g. beans
10. They can act as cover crops hence controlling soil erosion.
11. Some vegetables have medical value e.g malakwang, red amaranthus.

CLASSIFICATION OF VEGETABLES

Vegetables can be classified into two ways. i.e. according to the part eaten and family

ACCORDING TO PART EATEN.

1. **Leaf vegetables**
   - Cabbages
   - Amaranthus
   - Spinach.

2. **Fruit vegetable**
   - Egg plant
   - Tomatoes
   - Water melon
   - Cucumber
   - Pumpkin.
   - Okra

3. **Seed vegetables**
   - Cowpeas
   - G-nuts
   - Beans
   - Garden pea
   - Field pea

4. **Root vegetables**
   - Onions
   - Sugar beet
   - Garlic
   - Carrots
   - Irish potato
   - Turnip
   - Radish

5. **Flower vegetables**
   - Cauliflower

Family classification

Here vegetables are grouped into six families:-

1. **Leguminosae (pulse)**

   This include
   - Beans

- Pigeon pea
- G-nuts
- Garden peas
- Cowpeas

2. **Solanaceae (Tomato family)**

   This include
   - Irish potatoes
   - Egg plant
   - Tomatoes
   - Sweet pepper

3. **Brassicaceae (cabbage family)**

   It includes
   - Cabbage
   - Cauliflower
   - Radish
   - Turnip
   - Kale

4 **Cucurbitae (gourd family)**

Includes
- Pumpkins
- Water melon
- Cucumber
- Gourds.

5. **Alliaceae**

   This includes
   - Onions
   - Leek
   - Garlic

6. **Apiaceae**
   - Carrots
   - Parsely
   - Celety
   - Carriander
   - Parsely.

7. **Amaranthanceae**

- Amaranthus hybridus
- A. dubius
- A. caudatus

PROCEDURE FOLLOWED IN GROWING VEGETABLES

1. Choosing the site.

The site to be considered for growing vegetable should measure up to the following:-

a. The soil should be deep and fertile. Incase at low fertility fertilizers should be applied.
b. Availability of water, the site should have enough water supply hence the site should be close to a water source.
c. Distance from home. The site shouldn't be far from home for security reasons and easy management.
d. The area should be free from frost and the farmer to effect this should avoid valley bottom.
e. The place shouldn't be having shade since some vegetable like tomato and egg plant do not thrive well in shade.
f. Gentle slope or flat land and require for fair drainage.

2. Preparing a nursery bed.

A nursery bed is an area where seedlings are grown before they are transferred to the actual vegetable field / garden. The seeds can be planted in a seed bed, seed boxes or soil blocks.

Treatment of planting materials

- Seed dressing –coating seeds with pesticides e.g. copper Sulphate.
- Chitting or encouraging sprouting e.g. in potato seeds.
- Inoculation, usually done legumes where seeds are coated with right bacterial for nodule formation.
- Hot water treatment against viral diseases e.g in sugarcane and cassava.

Importance of a nursery bed.

- When propagating seeds which are too small to be planted directly into the soil.
- The crop seedlings are delicate and need great care
- Bulking up of planting materials is necessary like in sugarcane
- Helps in selecting healthy and strong seedlings.
- When cuttings to propagate the crop need special treatment e.g tea.

Procedure of making a nursery bed

- Remove all grasses, roots and tree stumps on the area.
- The place should be cultivated deeply to encourage proper root development.
- All large soil pieces should be broken down to encourage a fine bed.
- Incorporate manure containing phosphorous into the soil to improve fertility
- Leave the area to settle for Atleast 3 – 4 weeks before planting seeds
- Measure off the seed bed to a width of 1 metre and any length that you feel.
- Erect a shade on the prepared place to control light and water delivered to the seedlings.
- Make ridges across the bed where the seeds are to be planted.
- Place the seeds in the ridges and cover it with a thin layer of mulch to facilitate germination.
- Place a thin layer of mulch over the seeds to conserve soil moisture and control weeds.
- As soon as the seeds germinate the mulch should be removed since it may interfere with germination.
- The seeds should be watered twice each day in the morning and evening.
- After germination excess seedlings can be removed a practice called pricking out.
- At a later stage before transplanting seedlings are exposed to environmental conditions referred to as hardening off
- Transplanting should be done in the evening hour or morning to reduce the rate of water loss from the seedlings by transpiration.

3. Preparation of a seed bed.

A seed bed is a well prepared piece of land ready to receive planting materials.

- The land should be cleared of large bush, all trees and grasses
- All tree roots and stump should be removed in advance.
- The whole place should be deeply cultivated and big pieces of soil broken.
- The whole place should be measured to establish the size in accordance to the number of seedlings to be planted.
- The place should be leveled before planting seedlings.
- The whole vegetable should be along the contour of land to reduce erosion.

Nursery bed management

- Seedlings must be watered Atleast twice a day i.e in the morning and evening.
- Apply fertilizers to the seedlings to improve growth.
- Apply pesticides to control pests on the seedlings
- Spray fungicides on the seedlings to control fungal infections like dumping off
- Provide a good shade over the nursery bed to control damage to seedling due to harsh environmental conditions
- Remove diseased and excess seedlings from the nursery bed i.e prick out to

reduce disease spread and allow proper seedling growth.
- Weed the bed to reduce competition for nutrients and control disease spread

4. Transplanting

Precautions to be taken when transplanting

- Seedlings in the nursery bed should be well watered before lifting to reduce root breaking
- Seedlings should be lifted with soil in their roots to control distorting of roots.
- Care should be taken not to damage roots as it may deter proper crop establishment and development.
- Transplanting holes should be big enough to accommodate seedlings without bending roots since it may affect root development.
- Where fertilizers are used it should be thoroughly mixed with soil for efficient utilization by the seedlings.
- Seedlings should not be planted deeper than they were in the nursery for proper establishment.
- Transplanting should be done during the cool hours to reduce wilting of seedlings through excessive loss of water by transpiration.
- Seedlings should be watered after transplanting if the soil in the field is dry to provide adequate moisture for crop establishment and growth.

Transplanting the seedlings.

1. Only healthy, strong seedlings should be selected.
2. Watering of the nursery to soften the soil to ease transplanting and reduce root damage.
3. Transplanting should be done in the evening or in cool weather.
4. Thorough preparation of the seedbed by removing all tree stamps and roots remove any other vegetation Atleast two months before transplanting.
5. Dig holes before transplanting at the required spacing
6. Fill the holes with a mixed top soil and double supper phosphate or organic manure Atleast 2 -3 weeks before planting.
7. Top soil and sub soil should not be mixed but filled to holes separately
8. Transplant at the beginning of rain for easy crop establishment.
9. Provide temporary shade to the transplanted plant (seedlings)
10. Mulch around the seedling

11. Continue watering until the plant has fully established it's self.

5. Application of fertilizers.

- Vegetable require more of N, P and K which should be applied early for vigorous plant growth.

6. Weeding

Effective weed control is needed to ensure proper growth of the vegetable since they are more sensitive to competition.

7. Disease and pest control.

Vegetables are attacked by a number of fungal and bacterial diseases like dumping off, downy mildew, bacterial wilt, mosaic, dry rot, black rot, stem rot, and blight. The common pests are cut worms, termites, grasshoppers, caterpillars, mole crickets, aphids, thrips, nematodes and beetles.

8. Harvesting

Most vegetables are early maturing and are normally harvested manually after harvesting they should be kept in a cool place to that they don't go bad.

GROWING OF TOMATO SEEDLINGS FROM NURSERY BED PREPARTION TO TRANSPLANTING.

1. Select a good site for vegetable production
2. Remove all vegetation from the area where to prepare the seed nursery bed.
3. Cultivate deeply removing all roots from the bed.
4. Raise a nursery bed to facilitate good drainage.
5. Incorporate well rotten F.Y.M / compost or S.S.P fertilizer.
6. Level the soil by raking and remove any foreign material like stone, polyethene or glasses and break any big clods of soil.
7. Sow the seed at 0.5cm deep and cover lightly with soil
8. Spacing should be 15cm between the rows.
9. Mulch the bed lightly and remove after seeds have germinated
10. Erect a shade over a nursery bed to protect seedlings from harsh environmental conditions.
11. Water from the top of the shade twice a day, morning and evening using a watering can.

12. When the seedlings grow up to about 2.5cm high, prick out to ensure proper spacing and growth.
13. Weeding should be carried out with a garden trowel or suitable tool
14. Spraying seedlings with copper fungicides such as ridomil and diethane M45 to control late blight and other pests should be done.
15. As seedlings near 15cm in height, reduce the shade to ensure hardening off.
16. A week before transplanting water the seedling to ensure the soil is soft to avoid breaking roots.
17. A week before transplanting, remove all the shade to ensure full hardening off.
18. Transplanting should be done in the evening or cloud cast day to reduce water loss from the seedlings.
19. At transplanting use a trowel to remove seedling with soil around the roots.
20. At transplanting use a trowel to remove seedling with soil around the roots.
21. Water immediately after transplanting.

Diseases of tomato.

Tomato Blight-It's a fungal disease, it attacks leaves, stems and fruits causing brown – black sunken lesions

- It's very severe in humid weather.
- It can be controlled by spraying with copper fungicides such as ridomil and diethane M45.

Bacterial Wilt Its caused by pseudomonas solanacearum, it causes wilting and death of growing point and upper leaves.

- Its airborne and controlling its spread is difficult. However the following control measures are recommended:-
  - Remove and burn all infected plants.
  - Crop rotation
  - Use resistant varieties
  - Sterilize the soil by burning grass on top or apply formalin or boil
  - By fallowing

Tomato Mosaic -This is a rival disease, which causes curling and molting of leaves thus reducing the area of photosynthesis.

- It may be transmitted from tobacco shred or a smoker's hand

Its controlled by

- planting resistant healthy seeds
- burning all affected plants and planting healthy seeds
- smokers should wash their hands before touching tomato plants.

Pruning tomato

- One or two stems are left per plant.
- Remove lateral shoot weekly
- When 6 – 8 trusses of flowers pinch out the growing it this pruning will encourage the growth of good size marketable tomato.
- Remove leaves close to the ground to prevent the entry of blight.

Importance of pruning tomatoes

1. Improves the quality of fruits by exposing each to enough light.
2. Improve yields by ensuring big fruits due a reduced competition for nutrients between various branches
3. Makes spraying against disease more easy
4. Removes a micro climate that can encourage pests.
5. Harvesting becomes easier since fruits are properly exposed
6. Makes movement with in the garden simpler.

Staking tomatoes

There are several methods of staking tomato the common method includes:-

- Single staking
- Cross staking using a wire cross poles.

Importance of staking tomatoes

1. Controls fungal diseases that can attack tomato fruits especially soil borne diseases.
2. Improves the quality of fruits by preventing contact between soil and fruits.
3. Prevents pest attack of tomatoes by crawling pests
4. Exposes fruits to adequate air and light which improves quality.
5. Reduces wastage of pesticides by exposing fruits for easy spraying.
6. Make movement with in the garden easy.

LEGUMES

These are plants with root nodules which are able to fix nitrogen into the soil.

IMPORTANCE OF LEGUMES.

1. They are good sources of protein for human and other animals e.g. soybeans, with a protein content of 38 – 40%
2. In pasture they provide protein for grazing animals
3. Symbolic bacteria in the root nodules of legumes fix atmospheric nitrogen into the soil.
4. Fast growing leafy legumes are good for making green manure.
5. Legumes grow and cover the ground very quickly hence can be used as cover crops.
6. They are deep rooted hence help in recycling nutrient and opening up the soil thus increasing ration and infiltration.
7. In any dry area legume shrub provide fodder for animals.
8. Legumes regenerate faster and produce more nutritious vegetative parts hence can be continually grazed by animals.
9. Some legumes are used in the manufacture of medicine and dyes
10. Industrial products made from legumes such as ground nuts cake are fed to livestock.

CHARACTERISTICS OF LEGUMES

- They have trifoliate net vein leaves.
- Most legumes have root nodules which contain nitrogen fixing bacteria\
- They bear pods which contain seeds.
- They have a tap root system.

ROOT CROPS

They are crops which have swollen roots or under (ground stems) in which large quantities of starch are stored.

IMPORTANCE OF GROWING ROOT CROPS.

1. They grow in a variety of soil and can be good source of food for most of the areas.
2. They require little labour and attention hence cheap to produce
3. The tuber can lie in the ground until required and therefore available throughout the year.
4. Most root crops are resistant to drought hence can be produced in area of little rainfall.
5. Root crops are attacked by few pest and diseases as compared to other crops.
6. They are able to give high yield even in poor soil hence solving the problem of

hunger.

7. Compared to cereals and legumes, root crops require little processing before they are eaten.

LIMITATION OF ROOT CROPS GROWING.

- They are bulky and therefore difficult and expensive to transport
- They have a high moisture content hence difficult to store.
- They are low in protein, fat, vitamin, and minerals hence needs supplementation.
- They are propagated vegetatively therefore the planting material is difficult to transport.

PERENNIAL CROPS

These are crops which complete their life cycle in more than one year coffee, tea, cocoa, sisal, cashew nut, sugar cane, citrus fruits, pawpaw, banana, pineapple.

IMPORTANCE OF GROWING PERENNIAL CROPS IN AN AGRICULTURE SYSTEM.

1. The cost of establishing is spread over a number of gear hence can lower than that of annual.
2. Harvesting is continuous after establishment which reduces Labour.
3. They may be used as security in acquiring loans from the bank.
4. They increase value of land whenever planted.
5. The cost of controlling pest and disease is generally lower than that of annual.

LIMITATION OF PERENNIAL CROP PRODUCTION

1. Require a lot of land to be grown because of their wide spacing.
2. Perennial take long time to mature therefore waste long which could have been used for short term profitable crop.
3. Some of the perennial require irrigation so a permanent water source may be necessary.
4. Some perennial do not have seeds and therefore must be vegetatively propagated which is a bit expensive.
5. The processing of these crops may have to be done on the farm reducing the land area that could be used for crops.
6. The average yield for most perennials is low.
7. Perennials are very difficult to improve because breeding programmes are at along term nature and very expensive.

The perennials are also grouped into families e.g.

1. Rubiaceae - Coffee
2. Theacede - Tea
3. Sterculiaceae - Cocoa

4.	Anacardiaceae	-	Cashew nut	--	Mango
5.	Agavaceae	-	Sisal		
6.	Graminae	-	Sugar cane		
7.	Rutaceae	-	Citrus fruits		
8.	Caricaceae	-	Papaw (*Carica papaya*)		
9.	Musaceae	-	Banana		
10.	Bromeliaceae.	-	Ananas cosmosus (pineapple)		

GROWING COFFEE FROM NURSERY BED TO HARVESTING

1. Choose a suitable site with a good deep, well drained fertile soil from any shade.
2. Plough the area a depth of 0.6m to a tilth i.e. deep ploughing
3. Remove all plants roots, stones, weeds and break all big clods then level the soil using a rake.
4. Incorporate manure i.e. compost manure or SSP.
5. Sow/ plant seeds at a depth of 2.5m in a nursery bed at a spacing of 15cm by 15cm or 20cm x 20xm.
6. Mulch and water thoroughly using watering can mulches are removed immediately after germination.
7. Erect a shade to last atleast for one month.
8. water regularly nursery life last for 1 ½ year
9. weeding, thinning, pricking out should be done to avoid competition
10. control pest and disease
11. Hardening of the seedling before transplanting this is done by reducing water interval, reducing the shade.
12. Only healthy, strong seedlings should be selected.
13. Watering of the nursery to soften the soil to ease transplanting and reduce root damage.
14. Transplanting should be done in the evening or in cool weather to reduce water from the seedlings.
15. Thorough preparation of the seedbed by removing all tree stamps and roots or any other vegetation atleast two months before transplanting.
16. Dig a hole two months before transplanting at a spacing of 2.7m x 2.7m and 60cm deep and 60cm wide.
17. Fill the holes with a mixture of top soil and double supper phosphate or organic manure atleast 2 -3 weeks before planting.
18. Top soil and sub soil should not be mixed but filled to holes separately
19. Transplant at the beginning of rain after 1 ½ year when the plant is ready to leave the garden.
20. Provide temporary shade to the transplanted plant (seedlings)
21. Mulch around the seedling
22. Continue watering until the plant has fully emerged.

Examples of coffee diseases.

1. Coffee berry disease.
   Its caused by a fungus, which causes brown sunken spot on the berries making them difficult to pulp.
2. Antestia bugs
   This suck berries and cause zebra strip hey also feed on terminal bud and causes pan braking.

   Control is by spraying with parathion and open pruning.

   Other pests include:-

   - Mealy bugs
   - Coffee thrips
   - Lace bugs
   - Scale insect.

The above pest can be controlled by spraying with dieldrin and fenthion.

Advantages of pruning coffee.

1. It increases quality of berries by controlling over bearing.
2. Make harvesting easier.
3. destroys micro-climate for certain pest and disease by reducing over crowding
4. making weeding and spraying easier
5. It increases the yields.
6. keeps plants health and more vigorous

SEED BED

This is a piece of land and has been prepared to receive planting materials like wilting seeds, leaves, stems, leaves, bulb combs.

Seed bed preparation includes activities like ploughing, harrowing, digging, slashing, burning etc.

Tillage is the disturbance of land with an aim of killing weeds and providing a conducive atmosphere for successful plant establishment and growth.

TYPES OF TILLAGE

There are two main types of tillage i.e.
Primary

Secondary

PRIMARY TILLAGE

Is the initial preparation of land which can involve cutting trees clearing bushes and initial ploughing.

AIMS

1. To kill weeds by either burying or desiccation thorough exposure to sun
2. To burry crop residues of the previous season so as to provide manure and give space for the new crops.
3. To loosen the soil so as to allow water infiltration
4. To improve air circulation in the soil for proper root development
5. To disturb pest by exposing them to sun which easily kills them
6. Primary tillage can be used in controlling soil erosion by leaving the field rough.
7. Can provide good conditions for planting seeds through deep tillage and removal of obstacles.
8. To dig surface vegetation so that it can decompose more easily and enrich the soil.

SECONDARY TILLAGE

This is the subsequent seedbed preparation after primary tillage.

AIMS

- To cut vegetable materials and crop residue and mix it into the soil.
- To control weeds that may have come up after primary tillage
- To improve soil aeration by further breaking the soil clods
- To mix fertilizers /manure with soil.
- To cover the broadcasted seeds with soil.
- To level and firm top soil surface to as ease planting using any given method.
- To control pest by exposing them to ash environmental conditions.

WAYS IN WHICH TILLAGE CONTROLS PEST.

1. Exposes adult pest, eggs or larva to predators that eat them up and reduce pest population.
2. Expose adult pest egg or larva to harsh conditions that can cause their death.
3. It buries pest and kills them by suffocation thus reducing their population.
4. Destroys weeds which act as alternate host for pest.
5. Remove crop residues thus breaking life cycle of pest.
6. Destroys breeding place of pest causing them to run away,

FACTORS THAT DETERMINES A NUMBER OF TILLAGE OPERATION

1. The type of seed or planting, materials to be used e.g. small seeds require a fine seed bed which can only be produced after secondary tillage.
2. The initial condition of land – land which has few obstructions may only require one tillage operation.
3. The type of soil – sandy soils are very loose and therefore frequent cultivation destroys their structure making it more prone to erosion.
4. The cost of any tillage operation – the higher the cost the less the number of tillage operation.
5. Type of vegetation – A place with a number of trees and shrub will always require secondary tillage since it's difficult to get a good seed bed at the tillage.
6. The tools or equipment used – use of heavy tillage equipment can produce a fine seed bed even after the first tillage.
7. Season of the year – During dry season weeds are few and even have less power of regrowth hence one operation can be enough.

PLANT PROPAGATION

Propagation is a way in which plant population is increased by allowing plants to reproduce them selves.

Plants are propagated into two main ways i.e.

- Seed propagation
- Vegetable propagation

Treatment of planting materials

- Seed dressing –coating seeds with pesticides e.g. copper Sulphate.
- Chitting or encouraging sprouting e.g. in potato seeds.
- Inoculation, usually done legumes where seeds are coated with right bacterial for nodule formation.
- Hot water treatment against viral diseases e.g. in sugarcane and cassava.

SELECTION OF PLANTING MATERIAL

In order for a farmer to reduce the expenses the need to select the planting material that he is sure of.

CHARACTERISTICS OF A GOOD PLANTING MATERIAL

1. Should be readily available within locality to reduce transport expenses and time wasted in looking for it.
2. It should be pest and disease free to reduce the transmission of such diseases and pest to the seedling.
3. it should be easy to transport i.e. should not be bulky.
4. Incase of seeds should be of uniform size and shape to allow easy

mechanization during planting.

5. It should be easy to store so that it can use in future when needed.
6 Incase of seed they should have passed the dormancy stage.
7. The planting material should be highly viable to reduce the costs involved in filling up the gaps where they did not germinate.
8. Seeds should be of uniform colour to allow easy sorting and planting.
9. The planting material should be of high proven performance give high returns once planted.
10. Materials should be free from contamination by weeds.
11. Should be free from mechanical damage.
12. Incase of seeds, should be large enough.

SEED PROPAGATION

This is where seeds of mature plant having desirable qualities are used for planting.

ADVANTAGES

1. Seeds are not bulky and therefore are easy to handle and convenient to transport.
2. They can be stored for along time while retaining viability
3. Seeds are easy to treat against pest and seed born diseases
4. Seeds are easy to use during machine planting.
5. Seed planting is a quick method of increasing a crop population in a short period.
6. Some crops are difficult to plant vegetatively.
7. Plants raised from seeds have a longer life span than those raised vegetatively.

DISADVANTAGES

1. Some seeds are delicate hence difficult to handle during planting.
2. Seeds require special field preparation before planting more especially those with small seeds.
3. The method may introduce undesirable in the plant population.
4. Some seed may not breed true to type hence disappoint farmers
5. The formation of seeds requires special condition during pollination and fertilization.
6. Due to interference during pollination seeds may be formed but of a high degree of variability.
7. Crops raised from seeds take a longer time to mature.

VEGETATIVE PROPAGATION

This is the reproduction of plants from plants part that are not associated with reproductive organs.

ADVANTAGES

1. The offspring is similar to the parent in all ways hence preserve good mother characters.
2. Offsprings grows faster and mature early.
3. Offsprings are strong and hardly compare with seedling obtain from seeds.
4. Vegetative propagation is the best way for propagating plants with no viable seeds.
5. Daughter plants obtain food from their parents until they are sufficiently strong hence increasing chances of survival.
6. multiplication of the plant population is faster
7. over comes the problem of prolonged dormancy in some seeds

DISADVANATGES

1. It may cause over crowding due to the ability to establish quickly and grow fast.
2. It may cause over crowding due to the ability to establish quickly and grow fast.
3. The planting materials are quite bulky and therefore difficult to handle store and transport.
4. Due to their high moisture content vegetative materials are difficult to store.
5. Some vegetative methods of propagation are complex and hence need a lot of skill to execute.
6. A small hectare can be covered during planting as compared to seed propagation.

METHODS OF VEGETATIVE PROPAGATION

1. **Layering** - Mainly used in passion fruits.
2. **Grafting** - Used in most fruits like citrus, avocado, mangoes etc.
3. **Budding** - Can be used in fruits also like citrus.
4. **Tissue culture**- group of cells are developed into a new plant or plants

5 Use of storage structures

a. **Bulbs** - Used in onions and garlic.
b. **Bulbils** - Used in sisal
c. **Suckers** - Used in banana and pineapple
d. **Rhizomes.** - Used in ginger
e. **Runners** - Used in strawberry
f. **Corms** - Used in cocoyam
g. **Splits** - Used in pyrethrums
h. **Stem tubers**- Used in Irish potatoes.

i **Cutting -** Used in cassava sweet potato, clonal coffee.

GRAFTING

This is where two different stems are united in woody plants. The upper part of the union is called a scion while the lower part is called a stock.

PRINCIPLES OF GRAFTING

For successful grafting, there are about five principles which must be adhered to;

1. Compatibility – The scion and stock must be related or close to facilitate sexual hybridization.
2. Cambial alignment – The cambium of the scion and root stock should be aligned for the union form.
3. Timing of the grafting operation – Grafting must be done at a time when the root stock is in a proper physiological state.
4. Avoiding desiccation – After grafting operation make sure that all the surface is sealed off using wax or grafting tape around the joining
5. Pressure – Apply a pressure after aligning the cambium of the root stock and scion such that the xylem stays in contact.

REASONS FOR GRAFTING PLANTS

1. It changes the tree top from being undesirable to desirable
2. It makes it possible to grow more than one fruit or flower in the same plant.
3. Root stocks with desirable character like disease resistance, problem of water logging are used which may be beneficial to the scion and farmer.
4. It helps to propagate clones that cannot be propagated by any means.
5. It helps propagating special plants form e.g. seedless oranges.
6. Helps in change variety for more especially when the acid
7. Virus indexing – Plants having viral infection with no signs will show signs when grafted.

LIMITATION OF GRAFTING

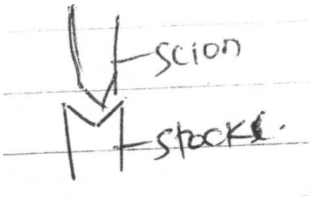
1. Incompatibility – this failure of grafted material to survive due to a difference in genetic constitution.
2. Requires a lot of skills and experience for successful grafting to occur.
3. Requires a lot of time for tangible results to be got.

METHODS OF GRAFTING

1. Top Wedge

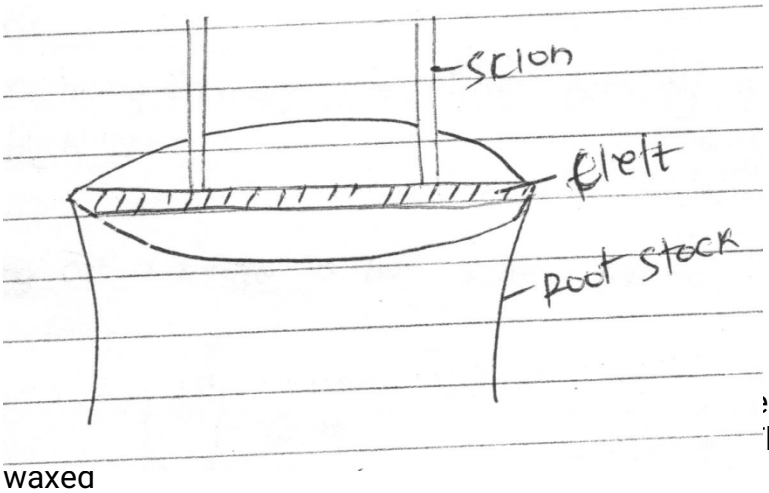
A cut surface of the scion forms a wedge that is inserted into a vertical slit on the root

stock that has been slash.

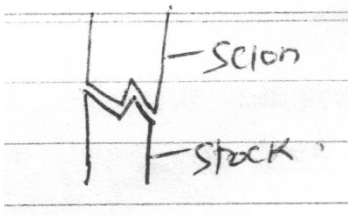


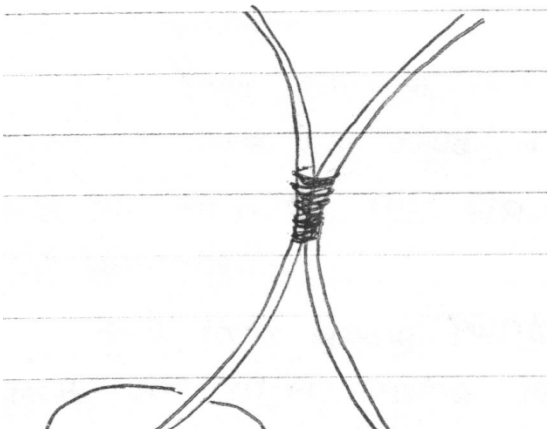
2. Cleft Grafting / Top working.

This involves grafting a scion into a canopy of a relatively large established tree.



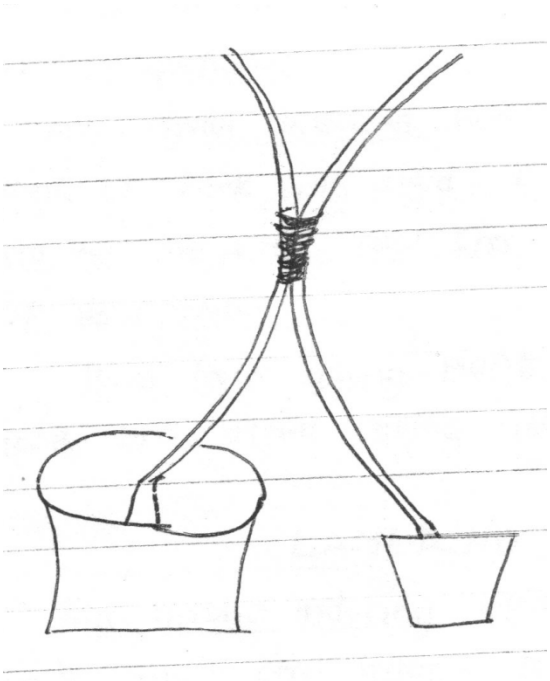
e dimensions. A stanty cut is
he two are fitted together and
waxed





4. Approach grafting

Here both the scion and stock remain attached to another plant until a secure union has been formed.

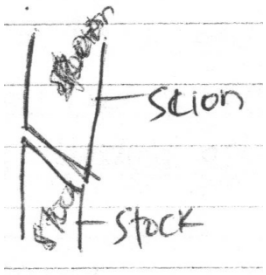


5. Bridge grafting

This is used in repairing damage free plant normally woody trunks of valuable established trees.

6. Splice grafting

A long slanting cut is made in both scion and root stock which are later tied together.



7. Bark grafting

The bark of the root stock is spit vertically and the prepared

BUDDING

This type of vegetative propagation the bud or scion is united with a seedling or a mature tree.

TYPES OFBUDDING

1. T-BUDDING

A t-Shaped cut is made on the back of the root stock and a bud is made on the back of the root stock and the bud fitted in

2. PATCH BUDDING

A rectangular piece of bud is cut of the root stock. A matching piece of bark with a bud is cut from the bud wood and matched into the prepared root stock.

3. TOP BUDDING

Buds from young plants are inserted at desired location on the stock and after setting the original branches are cut.

LAYERING

This involves inducing a part of plant usually a branch to produce roots while still attached to the mother plant.,

TYPES OF LAYERING.

1. SIMPLE LAYERING

This involves bending a stem and covering it with soil to produce roots.

2. TIP LAYERING

The whole shoot is bent and covered in the soil

3. COMPOUND LAYERING (SERPENTINE)

This is achieved by bending a stem several times and sometimes at a point of covering.

4. MOUNT / STOOL LAYERING.

A stem is cut just above the ground and the under shoot starts

5. TRENCH LAYERING

Here a trench is dug near the plant an a branch is layed on the trench to facilitate root development.

6. AIR / MACOTTING LAYERING.

The bark of a tree is open at a point and a wet mass is placed around the ring bar to keep it open. This stimulates root to develop at that point.

Assignment:

Define Dormancy
Causes

Correction
Methods used for testing seed viability.

CROP BREEDING / IMPROVEMENT

This is a process of changing crops genetically to suit man's needs of food, easy harvesting etc.

Or

It's a directed adjustment of crop plants to fit specific environment and production practices.

METHODS OF CROP BREEDING

1. MASS SELECTION

Here in breeding plants are selected basing on the individual character and these are used in the breeding programme.

2. BULK BREEDING

Products of F1 are grown in bulk before making a single plant selection depending on their performance.

3. PEDIGREE BREEDING

This is the most used method and its based on the performance of the ancestor and close relatives.

4. SINGLE DESCENT

Here one seed from F2 or F3 is used as a parent for the next generation.

5. RECURENT SELECTION

This is whereby the best individual resulting from a first selection cyle are crossed to generate the materials for the next selection cycles.

AIMS OF CROP BREEDING / IMPROVEMENT.

1. To increase crop yields so as to save the problem of hunger and food shortage.
2. To increase the nutrient content of the crop product to solve nutrient deficiency in consumers.
3. Produce better size and colour of fruits / seeds that can attract consumers.
4. To reduce the gestation period of a crop so as to solve food shortage.
5. Conferring disease and pest resistance in crop.
6. Production of crops that can tolerate adverse environmental conditions like drought, low soil fertility, high temperature.
7. To change growth characteristics of a plant in order to suit harvesting spraying and weeding.
8. to improve on the short life of the sowed crop production
9. To improve on seed viability character in plants so that there is no wastage of

seeds during planting.
10. Improving the taste and flavour of certain crop products.
11. To produce crop products that is easy to prepare as food for consumers.

CROP PROTECTION

Weeds, Pests and Diseases

Weeds

A weed is a plant growing where its not wanted or a plant out of place or a plant whose usefulness has not been established

Characteristics of weeds

i. Can grow in poor soils where crops cannot easily survive
ii. Produce seeds that can germinate even when not mature
iii. Some are parasitic to crops which increases their chances of survival
iv. Weed seeds can remain viable for a very long period of time
v. Most weeds are less palatable to animals hence not destroyed during grazing
vi. Most can tolerate adverse weather conditions like drought which most crops can't
vii. Some weeds are resistant to control measures like chemical and physical controls
viii. Most are resistant to common pests and diseases that attack crops
ix. Some are vegetatively propagated which increases growth rate
x. Some weed undergo dormancy which helps it survive harsh conditions
xi. Weeds have a fast growth rate as compared to crops which helps in colonization fa new places
xii. Some weeds produce toxic materials that exclude crops from the area of growth
xiii. Weeds produce a lot of seeds increasing survival chances
xiv. Some have a short life cycle which increases rate of colonization

Effects of weed in crop production

i. Irritate man and animals by causing skin itching and scratches
ii. Reduce quality of farm products e.g love grass and blackjack in cotton
iii. Some are poisonous to livestock and can cause death
iv. Irritate digestive tracts of animals leading to diarrhea and reduced appetite
v. Taint milk leading to loss of quality

vi. Make navigation difficult and can cause accidents on water e.g. water hyacinth
vii. Harbour pests and diseases which later attack crops
viii. Reduce human efficiency during farm operation by causing allergies
ix. Increase production costs on the farm since money and time have to be spent during control
x. Lower crop yields by out competing crops for nutrients
xi. Block water pipes and irrigation channels increasing costs of water management on the farm
xii. Obstruct power lines and rail roads which may cause accidents

Positive impact of weeds in crop production

i. Some can be eaten as food for both livestock and man
ii. Some are a good source of herbs used in making medicine
iii. They decompose and form organic matter in the soil
iv. Reduce evaporation rate of water from the soil
v. Protect soil from erosion
vi. Can be used in mulching crop gardens

Classification of weeds

According to life cycle;

a) ***Annual weeds***; these complete their life cycle with in a year e.g. wild finger millet, love grass, black jack, MacDonald weed, oxalis, amaranthus, goat weed, double thorn, black night shade and milk weed
b) ***Perennial weeds***; these complete their life cycle in more than a year. Couch grass, spear grass, wandering Jew, Nile cabbage, thorn apple, Sodom apple, nut grass, tick berry e.t.c.

According to habitat;

a) ***Terrestrial weeds***; these are weeds growing on land. They form the majority
b) ***Aquatic weeds;*** these are found growing in water e.g. Nile cabbage, water hyacinth, water lilies, water lettuce, and water weed (*Elodea spp*)

According to morphology;

a) ***Erect weeds***; these grow up right like Sodom apple, black jack, thorn apple, e.t.c.
b) ***Creeping weeds;*** these grow on soil surface like star grass, wandering Jew,
c) ***Broad leaved weeds;*** these have broadleaves. They are mainly dicots like Sodom apple, thorn apple, blackjack, tick berry, wandering Jew, milk weed, amaranthus, goat weed, e.t.c.
d) ***Narrow leaved weeds;*** these have narrow leaves. They are mainly grasses that are monocots like couch grass, star grass, nut grass, spear grass, love

grass

According to Physiology;

a) **C-3;** these use the C3 pathway in the utilization of carbondioxide during photosynthesis. They form the majority of broad leaved weeds
b) **C-4;** these use the C4 pathway in carbondioxide utilization during photosynthesis. They are mainly grasses with narrow leaves like spear grass and couch grass.
c) **Crassulacean Acid Metabolism (CAM);** these weeds use such a path way during their photosynthesis

According to botany;

This classification can be based on
Class
Order
Family
Genus
Species

Weed control methods

1. Preventive / legislation
2. Cultural
3. Mechanical
4. Chemical
5. Integrated weed management

Preventive method;

This is where measures are taken to prevent the introduction, establishment and spread of specific weeds in a non infested area.

The following measures are taken in the control of weeds;

a) Use of weed free seed during planting
b) Use of weed free manures
c) Giving animals weed free hay
d) Using machinery which is weed free
e) Keep areas around the gardens and farm weed free
f) Not allowing weeds to reach seed stage

Merits of the method

a) Maintains weed population below injurious level
b) Ensures a weed free environment for proper crop growth
c) No disturbance of soil hence preservation of soil structure
d) Reduces weed spread in an area
e) No wastage of time and Labour in weeding
f) Does not create resistance in weeds.

Cultural weed control

It's the modification of general farming practices to reduce the impact of weeds
The modifications may include the following practices;

1. Crop rotation; this break the life cycles of parasitic weeds hence controlling it.
2. Proper spacing; it denies weeds access to enough light and space hence controlling it
3. Mulching; cuts off light supply to the weed seedling hence controlling weeds
4. Flooding; it suffocates the weeds by denying it oxygen supply resulting into death
5. Timely planting; this gives the crops an early and healthy start which enables it to out compete the weeds.

Mechanical/ physical weed control

It's where physical energy is used in the control of weeds. It may involve the following

- Hoeing weeds
- Mowing weeds
- Ploughing weeds
- Burning weeds
- Cutting weeds
- Slashing weeds
- Uprooting weeds
- Exposure to heat or flaming

Merits of mechanical weed control

- No use of chemicals hence no environmental pollution

- Burial of weeds helps in providing organic matter after decomposition
- Improves water infiltration by breaking soil crusts
- Tilling soil can improve aeration and tilth
- Depletes weed seed bank
- Its fast at weed control once carried out properly

Limitations

a) Its difficult to control weeds in rows
b) Increases water and organic matter loss in soil
c) It can easily lead to loss of soil structure with repeated operations
d) Dust may be raised in dry soil leading to pollution
e) Weeds may be exhumed leading to fast growth
f) May increase Labour costs on the farm hence increased production costs

Biological control

It's the use of natural enemies of certain weeds in controlling their growth and establishment

Advantages of biological control

a) Usually permanent hence control weeds continuously
b) It does not require additional inputs
c) Does not have side effects like pollution
d) Organisms are always host specific
e) Biological agents are self dispensing
f) After establishment, no additional inputs are required

Limitations

a) Its slow at controlling weeds
b) Establishment may fail leading to losses
c) Some attack crops causing loss
d) They require a high initial cost
e) Cannot completely eradicate the weeds
f) Results are not guaranteed

Chemical weed control

It’s the use of herbicides in the control of weeds. Herbicides are agricultural chemicals that control plant growth

Classification of herbicides

Classification according to use

1. **Selective herbicides**; these kill or impair growth of certain plant species while sparing others. Examples of selective herbicides; Atrazine, Simazine, cotorum, 2, 4-D, MCPA, and MCPP
2. **Non selective;** these kill indiscriminately all plants they come into contact with i.e kill both crops and weeds. Examples; Glyphosate, Paraquat (Gramoxone), Diquat, e.t.c.

Classification according to mode of action

1. **Contact herbicides**; these kill any plant tissue they come into contact with whether for the crop or weeds. They are applied on foliage of weeds. Examples are; Paraquat, Bentazone, Propanile.e.t.c.
2. **Translocated or systemic herbicides**; these are absorbed by stems, leaves or roots and move through vascular system to plant organs where they exert their effects. Examples; 2,4-D, 2,4-T, Atrazine, Simazine, Cotorum, Diuron, Dalapon, Dicamba, MCPA, MCPP, e.t.c.
3. **Soil sterilants;** these prevent growth of all plant (weeds and crops) once in soil at high concentrations. They are mainly used at rails roads and pipelines. Examples are; Diuron, Bromacil, Simazine, e.t.c.

Classification according to time of application

1. **Pre-planting herbicides;** these are applied before the crop is planted. Such herbicides are mainly non-selective hence must be applied in this way to reduce crop damage. Examples are; Glyphosate, Paraquat (Gramoxone), Diquat, e.t.c.
2. **Pre- emergence herbicides**; these are applied before emergence of crops or weeds. They prevent seedlings or seeds of weeds from to establish. Examples are Paraquat, Diquat and Atrazine, e.t.c.
3. **Post-emergence herbicides**; these are applied crop germination and establishment. They are mainly selective herbicides that may not easily harm crops. Examples are; MCPA, 2,4-D, Atrazine, Simazine, e.t.c.

Advantages of using herbicides in weed control

1. It’s very effective in controlling stubborn weeds like couch grass

2. Reduces tillage of soil hence conserving soil structure and moisture
3. It requires less Labour hence can reduce production costs
4. Herbicides can be easily applied in gardens where crop morphology does not allow use of mechanical means
5. Use of pre-emergence herbicides ensures a weed free environment hence high crop yields
6. Reduces chances of destroying crop roots since it does not involve tilling land
7. Weed free environment results into high quality and quantity of crop produce

Limitations of herbicide use

1. Herbicides are expensive to buy
2. They are poisonous to man and livestock hence difficult to store
3. Some persist in soil and cause environmental pollution
4. They require skill to apply
5. Some can be absorbed by crops and concentrated in crop products eaten by man
6. Some are not readily available in rural places where most farmers are found
7. can be washed into water bodies and kill aquatic organisms

Precautions to take when using herbicides

1. Apply the recommended rate to reduce damage to crops
2. Apply at the correct stage of weed growth for effectiveness
3. Do not apply during rain or when it is threatening to rain since the herbicide can be washed off
4. Avoid spraying during a windy weather since the herbicide can be blown off the weeds reducing effectiveness
5. Wear protective clothes during application to protect your self
6. Do not eat or smoke while spraying since you can easily take in the herbicide
7. Avoid applying the herbicide when you have an open wound or cut
8. Herbicide containers should be properly disposed off in pit latrines to reduce chances of environmental pollution
9. avoid herbicides coming into contact with food
10. do not pour left over chemicals in water sources

Ensuring effectiveness of herbicides

1. Apply at the correct recommended rate i.e. correct concentration
2. Apply at the correct stage of weed growth i.e. apply when weeds are still young
3. Ensure that the weeds are fully wetted
4. Do not spray during a windy weather since the herbicide may be blown away from target area
5. Do not apply during rain of when it is threatening to rain since the herbicide can be washed off
6. Apply at the correct stage of crop growth to reduce damage to crops
7. Ensure that the herbicide cannot affect crop produce once applied
8. Always apply the correct herbicide for the right weeds

PESTS

A pest is an organism that damages or causes harm to man, his animals, crops or possessions.

Important terms in pest management

Economic pest, this causes recognizable damage of about 5 to 10%
Economic damage; damage done to crops by pests that warrants artificial control
Economic injury level, it is the lowest pest population that can cause economic damage. It varies from pest species depending on;

- Mode of feeding
- Stage of crop growth
- Stage of pest growth
- Season of the year
- Part of crop attacked

Economic threshold; pest population density at which control measures should start to prevent an increasing pest population from reaching **economic injury level**
Pest complex; it is where a crop is attacked by pests and diseases at the same time.

Pest classification

- Key pests; pests whose population usually remains above the economic level e.g cotton boll worms
- Occasional pest; these occur in certain regions at specific periods e.g, Jassids, aphids, e.t.c.
- Migrant pests; these are non residential and appear periodically for a short time e.g army worms, locusts, e.t.c.
- potential pests; these cause no significant damage under the conditions

currently prevailing in the agro-system e.g red banded leaf roller
- monophagous; feed on a particular species of crops e.g rice
- oliphagus ; these feed on various species of crops from the same family
- polyphagus ; these feed on various species of different family
- piercing and sucking pests; these pierce crop tissue and suck fluids. E.g Thrips, aphids, scales, mealy bugs, cotton stainers and seed bugs, cotton leaf hoppers,
- Biting and chewing pests; these have strong mouth parts that they use to bite and chew crop parts. Examples are grass hoppers, locusts, caterpillars, rodents, weevils, bean bruchids, e.t.c
- Field pests; these destroy crops while in the garden. They include monkeys, rodents, birds, stalk borers, caterpillars, weevils, cotton stainers, termites, e.t.c
- Storage pests; these destroy or damage crop produce in stores. Examples are bean bruchids, maize weevils, red flour beetle, e.t.c.

Damage caused by pests to;

a) growing crops
b) stored produce

Growing crops

- Eat planted seeds in soil reducing viability
- Eat crop roots causing plants to fall or wilt
- Eat crop leaves reducing photosynthetic capacity of crops hence yield
- Tunnel through stems weakening it
- Make holes in root tubers leading to rotting
- Suck crop sap leading to wilting
- Can eat crops completely
- Can transmit crop diseases
- Eat crop flowers causing low yield
- Bore into fruits and causes rotting
- Scratch fruits reducing their quality

Stored produce

- Eat produce completely reducing quantity
- Bore into stored seeds reducing quality
- Destroy endosperm hence reducing seed viability
- Cause bad smell in stored produce
- Deposit feaces in produce reducing quality
- Promote rotting of produce
- Destroy containers in which produce is stored
- Discolour produce leading to loss in quality
- Cause wet heating of produce
- Reduce nutrient level of stored produce
- Mix up produce lowering quality

Effects of sucking pests on crops

- Transmit pathogens to crops
- Inject toxic saliva into crops affecting growth
- Create entry points for pathogens into crops
- Suck sap from crops causing wilting and stunted growth

Indirect effects of pests in crop production

- Cause famine and suffering to humans by destroying food crops
- Increase costs of production in agriculture through buying pesticides
- Cause stunted growth in crops
- Reduce quality of crop products affecting prices
- Cause annoyance to farmers
- Can cause poverty to farmers
- Chemical control of pests can cause environmental pollution
- Some new pest species can come up when chemicals are used to control pests

Pest control

Factors considered before controlling pests

1. Pest population; high population requires immediate intervention
2. Reproductive rate of pests; high rate of reproduction may mean high pests population in a short time
3. Part of crop affected; pests that attack vital parts of a crop like flowers must be controlled immediately
4. Crop response to attack; when a crop shows a high response, then control must be immediate
5. Feeding habits of pests; biting and chewing pests cause a lot of damage hence must be controlled immediately
6. Presence of pest predators; once a pest has predators, artificial control may not be necessary.
7. Weather conditions; harsh weather may not favour pests hence in such conditions control may not be necessary
8. Pest mobility; highly mobile pests like those that fly can spread fast hence control is urgent
9. Presence of alternate plants; during control, alternate hosts must be eliminated as well.
10. Cost / benefit analysis; control must not be more expensive in relation to the cost of produce

The following precautions should be taken to have successful pest control

1. Should have good knowledge of pest classification and behavior
2. Make good pest sampling techniques
3. Should have good knowledge about pest predators
4. Know the type of food eaten by the pest

5. Know the pest habitat
6. Know the stages of pest development
7. Consider economic damage of the pest
8. Control pests at the favorable weather conditions

Chemical pest control

This is the reduction or prevention of pest damage by use of chemicals to attract, repel or poison pests.

Merits of chemical pest control

It is quick at controlling pests
Chemical application is standardized hence easy to use
The method does not require action from the community
Broad spectrum chemicals are economical to use
It is labor saving
It is very effective in killing pests

Demerits

Chemicals can pollute the environment
They are expensive to buy
Some can kill pest predators increasing pest populations
They require regular application
Chemicals create resistance in pests against pesticides
They may require a lot of skills to use

Characteristics of a good pesticide

1. Should be toxic to pests
2. Should not harm pest predators
3. Should be harmless to livestock
4. Must be reasonably persistent in soil to stop continuous application
5. It should be harmless to crops
6. Should leave no taints or residues on crop products
7. Should be suitable for practical formulation
8. Should be cheap to buy

Classification of pesticides

According to mode of action;

Stomach poisons- these are eaten then kill the pest. They are good for sucking pests
Contact poisons- can enter the body system through the skin or cuticle
Fumigants – chemicals are carried in air and breathed by pests. They are good for soil pests and those in crevices
Attracters – these are pheromones that attract pests so that they can be killed
Repellants- repel pests from one area or crop

According to group of pests controlled

Insecticides - kill insects
Acaricides – kill ticks
Fungicides - kill fungi
Herbicides – kill weeds
Nematicides – kill nematodes
Virulants - kill viruses

According to origin of the chemical
Botanicals are derived from plants like pyrethrum
Chlorinated hydrocarbons are organic compounds with chlorine attached on their bonds. They were the first to be developed and include DDT (Dichloro diphenyl Trichloroethylene), Aldrin, Lindane, methomyl, e.t.c.

Cultural pest control

It is the reduction of pest damage through the manipulation of agricultural practices that are normally applied in crop growing. The common cultural practices that control pests are;

1. Using planting materials that are free from pests to control spread and establishment
2. Removal of infected crops from the garden to minimize spread of pests
3. Practicing crop rotation that breaks the life cycle of pests
4. Planting crops on time so that they can escape pests that come late in the season
5. Timely harvesting which reduces pest damage to crop products
6. Planting pest resistant varieties of crops. Resistance can be pseudo or real.
7. Use of trap crops that help in eliminating the pests
8. Practicing close seasoning where community can be easily mobilized
9. Mulching the gardens to control pests like the banana weevils
10. Quarantine measure that reduces spread of pests from one place to another
11. Proper drying of crop produce to reduce pest damage during storage
12. Practicing inter cropping that may involve crops that produce hormones to scare away pests
13. Application of organic manures may kill some soil pests like nematodes
14. Flooding can suffocate and kill some pests
15. proper spacing of crops that may discourage aphids

Advantages of cultural pest control

1. It is continuous making the method economic
2. It is cheap compared with other methods like chemical and physical
3. Can be easily integrated with other control methods
4. Does not pollute the environment
5. Cannot develop resistance in pests
6. The practices can improve soil properties like soil structure, fertility, e.t.c.

Limitations of cultural pest control

1. The measures cannot eradicate pests but keep population at optimum
2. The method does not have dramatic results hence farmers are not easily convinced that it works
3. Requires maintenance of practices for effectiveness
4. Most practices are aimed at one pest
5. May require a lot time and energy to apply
6. May not address the problem of pest outbreak since it is slow
7. It is not standardized hence difficult to apply

Physical pest control

It is the reduction of pest damage to agricultural produce through the use of special physical and mechanical measures. It is the oldest and most primitive method of pest control. Physical means of pest control are;

1. Hand picking and killing. It is done with the less mobile pests that are big enough to be seen by our eyes
2. Construction of physical barriers like trenches to control caterpillars
3. Use of extreme conditions to kill or scare away pests
4. Use of electro magnetic waves that can kill pests
5. Use of irritating sound to scare away pests
6. Dehydration of pests using sand, ash or salt.

Advantages

1. Pests are destroyed completely
2. It allows the farmer to assess the pest situation on crops
3. Does not pollute the environment
4. Cannot create resistance in pests
5. It is cheap where area to be covered is small
6. Control methods are easy to learn and use

Disadvantages

1. May require a lot of labor for large plantation
2. It is not effective on highly mobile pests
3. It is time wasting

Biological pest control

It is the reduction of pest damage to crops by using natural enemies

Merits

1. It is environmental pollution free
2. No development of pest resistance

3. Pest population does not blow out of proportion
4. Does not affect pest predators
5. It is self adjusting hence a farmer does not need to think about it
6. It is a cheap method of pest control

Demerits

1. It is slow in operation
2. Biological agents may attack crops or spread disease
3. It may not eliminate the pests completely
4. Biological agents may fail to establish

Characteristics of a good biological agent

1. Should have a high searching ability for the pests
2. Must be host specific
3. Should have a high reproduction rate
4. Should be easy to multiply artificially
5. Must attack pests at the correct stage
6. Should not attack crops

Integrated pest management (I.P.M.)

It is the development of a set of practices that maintain pest populations at a level that cannot cause economic loss to the farmer.

Characteristics of IPM

1. It does not have set packages for every situation
2. It emphasizes a holistic approach to pest control
3. It allows existence of a pest with in a balance
4. It emphasizes minimum intervention with pesticides
5. It is not a universal solution to crop protection needs
6. Chemical control is used as a last solution
7. It requires understanding of systems and dynamics of pest control

Advantages of I.PM.

1. Its cheaper since it utilizes natural factors
2. More environmental friendly since it discourages use of chemicals
3. Traditional farmers can use it since it involves a mixture of traditional and modern methods of pest control
4. Cultivates a spirit of self reliance in pest control
5. It has the potential of offering permanent solution to pest problem

Constraints

1. Demands a detailed understanding of the present agro-ecosystems and their dynamics in response to intervention

2. It is difficult to develop standard packages that will suit every farming system
3. Results are not dramatic hence farmers cannot be easily convinced
4. Farmers are often ill equipped with knowledge and means to institute IPM
5. A holistic approach to IPM is difficult to realize due to limited knowledge

Crop diseases

A disease is a physiological disorder or structural abnormality which is harmful to a crop.

Causes of diseases in crops

1. Pathogens; bacteria, fungi and virus can cause diseases in crops
2. Mineral deficiency; this causes disease conditions like chlorosis, stunted growth, e.t.c.
3. Wind; it causes flattering and breaking of plant stems
4. Inadequate light; it causes etiolation in crops
5. Drought or water stress; causes crops to wilt and die
6. Hail damage; it bruises crop parts and destroys crop leaves completely
7. Water logging; excess in soil can cause wilting in some crops due to limited root development and air
8. Chemical effects; herbicides or pesticides used wrongly can scorch crops
9. Air pollution; it causes disease symptoms in crops

Signs of disease in crops

1. Cause **rotting** of crops
2. Causes **wilting** of crops due to blockage of xylem
3. Causes **hyperplasia**; abnormal fast rate of cell division
4. Causes **hypertrophy**; abnormal enlargement of cells leading to galls and warts
5. **Chlorosis**; yellowing common to crops with root or vascular diseases. Virus disease and nutrient deficiency can cause chlorosis
6. **Etiolation**; extended growth due to excessive or diseases like Bakanae disease of rice
7. **Stunting or dwarfing**; viral and bacterial diseases like Ground nut rosette and tomato bushy stunt. General nutrient deficiency and root diseases can cause stunting
8. **Anthracnose**; dark, sunken, necrotic spots or patches with raised borders on leaves or fruits
9. **Blights**; sudden and fairly extensive shriveling and death of certain areas of the plant. Can be caused by fungus and bacteria
10. **Cankers;** localized open sunken wound with raised margin usually found on wooden crops
11. **Damping off**; basal rotting of seedlings causing collapse and death
12. **Leaf spots**; limited areas of necrotic tissue. Spots can be circular, lenticular, angular, e.t.c.

13. **Mildews**; mold growth over leaf surface
14. **Rots;** necrosis of a large area of tissue on leaves, stems, roots, e.t.c.
15. **Rusts**; powdery sporing pustules on the leaves of stems usually yellow brown or orange
16. **Leaf curl;** malformation of the leaf lamina due to irregular formation caused by pathogens.
17. **Smuts**; black, powdery spore masses are produced on various plant parts.

Spread of disease

- Vectors like leaf hoppers, white fly, and e.t.c.
- Erosion water
- Wind
- Planting material/ seeds
- Contaminated fertilizers
- Contaminated soil
- Garden tools
- Through pollen or pollinating agents
- Through irrigation water

Common symptoms viral diseases

- Abnormal curling of leaves
- Chlorosis
- Stunted growth
- Abnormally short internodes (rosetting)
- Poor yield
- Mottling of leaves
- Yellow streaks

Control of crop disease

- Crop rotation
- Planting resistant varieties
- Removal diseases crops from the garden
- Proper weed control
- Proper spacing
- Hot water treatment
- Spraying with chemicals like fungicides
- Planting disease free seeds
- Destroying alternate hosts
- Close seasoning
- Quarantine measures
- Timely planting and harvesting

PASTURES

TERMS USED

1. **Pasture** - This is a fenced area demarcated forage plant usually improved and on which animals are grazed.
2. **Fodde**r – This is a grass or legume that is cut and carried to the stalk for in door feeding.
3. **Forage** – This is a plant grown primarily for feeding livestock.
4. **Hay** – This is feed produced by hydrating green forage to a moisture content of 15% or less.
5. **Silage** – This is forage preserved in a succulent condition by partial formation.
6. **Palatability** – This is the relative attractiveness of feed to an animal.
7. **Herbage** – This refers to leaves, stems and other succulent part of forage plant that animals can feed on.
8. **Stocking rate** – This is the number of animal grazing in unit area of pasture land irrespective of reliable or available herbage.
9. **Carrying capacity** – This is the number of animals a given pasture is able to support for a given period of time.

TYPES OF PASTURES

There are two main types of pasture i.e.
Natural
Ley

NATURAL PASTURE

This is open area with a dense cover of native grasses and other plant species.

ADVANTAGES

- forage plants found in natural pasture are well adapted to natural condition hence can survive even under poor management,
- Natural pasture contains a variety of forage plant needed in the animal diet.
- They are found in areas that are difficult to cultivate hence help in the utilization of such idle places.
- They can support a large population of local livestock species like goats, sheep, and cattle.
- They are cheap to maintain since they do not require a lot of care.
- They require fewer inputs during improvement.

DISADVANTAGES

- They are less productive in terms of herbage yields and nutritive value.
- The grasses mature very fast becoming stemy and coarse hence reducing palatability and nutritive value.
- They are usually grazed communally hence high chances of more livestock using it leading to overgrazing.
- Due to poor management of natural pasture livestock diseases spread very fast from herd to herd.

LEY PASTURE

These consist of improved grasses and legumes that provide high quality forage. Ley pastures are used for intensive farming and particularly for dairy cattle.

LIMITATIONS

1. High cost of establishment i.e. money is needed to prepare the land, buy seeds and fertilizers.
2. Lack of viable seeds – seeds are not readily available on a commercial basis for Ley pastures.
3. Poor quality animals – Most farmers rear poor quality animals which cannot give profitable returns to cover the cost of leys.
4. Poor managerial skills – Most farmers lack basic knowledge and skills of managing Ley so that they can be productive for a long period of time.
5. Poor soil – Most farmers are not willing to surrender their fertile soil for Ley pasture production.
6. Unreliable rainfall – Ley pasture production requires rainfall which is not less 800mm annually and must be well distributed.

IMPORTANCE OF PASTURES

1. They provide organic matter to the soil after rotting.
2. They provide a wide range of nutrients to grazing animals.
3. They help in utilizing idle land.
4. Deep rooted pasture plants recycle plant nutrients from deeper layer to soil surface for rooters to use.
5. They can break life cycle of pest when planted in a rotation with crops.
6. They can reduce water evaporation from the so acting as a cover.
7. Pastures are the cheapest source of feeds for animals
8. The root of pasture plant will bind soil particles together hence reducing soil erosion.
9. Pasture plant, particularly legumes improves the soil fertility by fixing nitrogen

into the soil.

IMPROVEMENT OF NATURAL PASTURES

1. Fencing - The area should be fenced to exclude wild animals and intruders.
2. Remove bushes and dense tree canopy so that the pasture grasses can receive enough light.
3. Weeds control – Poisonous and notorious weeds should be removed.
4. Provision of water to animals – Watering points should be well distributed to avoid over grazing and trampling on pastures in some places.
5. Erosion control – Stolonferous grass spp should be planted on bear surface or in over grazed area to reduce soil erosion.
6. Over sow – this is the introduction of improved forage spp more especially legumes in natural pasture to improve nutrient content.
7. Control grazing / rotational grazing / strip grazing – This encourages efficient forage utilized and reduces over grazing.
8. Establishing fodder bank that can be fed to animals when fresh herbage is scarce.
9. Distribute salt licks evenly in a pasture to stop animals from creating small path in a pasture as they move to the point with the licks.
10. Practice control burning so that all pasture with parasites are got rid of to give way for the young and nutritious forage.
11. Draining water logged area so as to encourage proper forage growth and control parasites

FACTORS TO CONSIDER BEFORE ESTABLISHING A PASTURE

1. Type of soil – A farmer should consider a good soil with a good ability to retain moisture
2. Topography – pasture land should have a gentle slope which allows easy use of machines during seed bed preparation and planting.
3. Climate – The area should have adequate rainfall with about 800mm during dry periods.
4. Planting materials – There should be good quality planting materials that ensure good pasture establishment.
5. Cost of production – The farmer should make sure that the expense involved in pasture establishment can be met from the income of the animals.
6. Availability of pasture seeds – The pasture under consideration should have readily available seeds with in the environment.

CHARACTERISTICS OF A GOOD PASTUER SPECIES.

1. It should be easy to establish hence reducing cost involved in replacing the seeds that failed to establish.
2. It should be able to provide herbage even in times of scarcity
3. It should be drought resistant. In order to meet this deep rooted species are

always preferred.

4. It should be easy to manage i.e. easy to plant, weed and harvest.
5. It should be highly palatable so that the animals can take it.
6. Should match with the nutrient requirement of animal.
7. It should show a high resistance to grazing i.e. the species should be able to regenerate after grazing and persist for atleast three years.
8. It should be highly resistant to pest and diseases that can attack the pasture.
9. Should be able to produce a large quantity of dry matter in a year for the animals to graze on.
10. It should have a suitable height from the ground to allow easy grazing by the animal.
11. It must be a pasture that can be easily mixed with other pasture species without having any effect on them or being affected.
12. It should have readily available seeds that can be used for propagation.

TYPES OF PASTURES

Pasture is divided into two broad groups. i.e.

- Pasture grasses
- Pasture legumes

Examples of pasture grasses

- Guinea grass - ***Panicum maximum***
- Rhode grass - **Chloris *gayana***
- Congo Signal grass - ***Brachiaria ruziziensis***
- Elephant grass - ***Pennisetum purpureum***
- Kikuyu grass - ***Pennisetum clandestinum***
- Nandi grass - ***Setaria anceps***
- Thatch grass - ***Hyparrhenia rufa***
- Star grass - ***Cynodon dactylon***

Examples of common pasture legumes

- Green leaf Desmodium - ***Desmodium* intortum**
- Silver leaf Desmodium - ***Desmodium uncinatum***
- Stylo - ***Stylosanthes gracilis***
- Glycine - ***Glycine wightii***
- Centro - ***Centrosema pubescens***
- Lucerne - ***Medicago sativa***
- Clovers - ***Trifolium spp***

ADVANTAGES OF INCLUDING LEGUMES IN A PASTURE

1. They fix nitrogen into the soil hence improving soil fertility for other plant species.
2. They show a high resistance to drought hence can be relied on during the dry season.
3. They increase the palatability of the pasture since they are highly palatable.
4. Since they are deep rooted, they help in recycling plant nutrients for use by other plant species.
5. They reduce cases of bloat in animals since they are not very succulent.
6. A good number of them have broad leaves hence have the ability to control soil erosion.
7. The legumes supply protein to the animals which supplement the grass.
8. They give longer grazing period since they mature at different times.
9. They produce better quality and quantity of foliage for the animals.

ADAPATATION OF FORAGE PLANTS TO THE ENVIRONMENT

1. They produce very many feeds which increases their chances of survival
2. Their seeds are light hence can be easily dispersed by wind.
3. they can withstand defoliation and regenerate quickly
4. They have short life cycle hence able to utilize the shortest period of good conditions
5. some have thorns and hair which discourage animals from eating them
6. Some species produce chemicals which keep off animals
7. Some have under ground stem (rhizomes) which will sprout when the leaves and stems are destroyed.
8. Some grass seeds posses hard seed coat that can not be destroyed by the animal digestive system.

CONSERVATION OF HERBAGE.

Herbage can be conserved into two major ways i.e.

- Hay
- Silage

HAY

CHARACTERISTICS OF A GOOD HAY

1. Good hay should be leafy since leaves are richer in food value compared to other parts of the plant.
2. Should be prepared out of herbage cut at the stage near flowering when the plant is highly nutritious.

3. It should be green in colour since the green colour signifies the presence of Vit .A
4. It should be free from dust and moulds which reduce palatability
5. It should be soft and pliable for easy consumption by the animals.
6. It should be free from weeds and poisonous plants.
7. It should have a smell which is a characteristic of the plant from which it is made.
8. The moisture content of hay should not exceed 15% since high moisture may cause rotting.

FACTORS AFFECTING THE QUALITY OF HAY

1. The species of grass – some grass species produce high quality hay since they can be easily turned and have nutrient content.
2. Storage – Proper storage of hay by protecting it from rain and sunlight preserve the quality.
3. Stage of cutting the grass – Grass cut before flowering produces high quality hay than that cut after flowering.
4. Level of drying – Poorly dried hay becomes moldy and over dried hay lacks Vit. A

PROCEDURE OF MAKING HAY

1. Select a suitable plant species with high nutrient to be used in the making of hay.
2. Cultivate the plant species on a good soil where it can obtain the required nutrients.
3. Harvest the plant species just before flowering when it contains a lot of nutrients.
4. Dry the hay to a moisture content of about 15%
5. Tie the hay in bales and prepare it for storage
6. The hay should be stored in a place well protected from rain and sunlight to preserve the quality.

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SILAGE

This is the herbage cut before flowering and converted into succulent feed through the process of fermentation. It can be made from any succulent green material such as

sweet potatoes vines, young maize, sunflower sorghum, young Guatemala grass and elephant grass.

N.B. High protein foliages mixed with starchy foliages in ratio 3:1 give well balanced silage.

THE PROCESS OF ENSILING (MAKING SILAGE)

1. Cut the grass when it is about to flower and incase of legumes when they have formed pods.
2. Chop the grass into small pieces of about 4cm long that can be easily packed.
3. Park the material in the air tight chamber (silo) and compress it to exclude air.
4. Add fermentable water soluble carbohydrates like **molasses** which provide energy to the microbe during fermentation process.
5. Add **urea** at a rate of 5Kg per ton so as to increase nitrogen content of the silage.
6. When the silage chamber is full, seal it off from the atmosphere to exclude air and water.
7. Allow the materials to ferment for Atleast three weeks
8. Monitor the temperatures in the silo to ensure proper fermentation. When temperatures drop, molasses should be added to provide energy to the microbes carrying out fermentation.

FERMANTATION PROCESS

a. The material is under fermentation through the action of lactobacillus bacteria.
b. Organic acids are produced and the major one being lactic acid
c. Lactic acid gives silage a good flavour, kills off the harmful microbes and acts as the preservative for silage.
d. The PH has to be low between 3.8 -4.3 and the temperature must rise to about 37.8^0C to encourage fermentation by lactobacillus.
e. If the temperatures are low, add more **molasses** into the silage.
f. Add water to lower temperature incase they are high.

N.B. Low temperature can be avoided by:

1. Partial drying of the material before ensiling to reduce moisture in the silage.
2. Filling the silage chamber rapidly but compressing the material lightly.
3. Sealing the silo immediately after the final packing to exclude air as much as possible.

N.B. Forage crops contain other species of bacteria such as *clostridium ssp* which convert sugars and lactic acid to butyric acid.

Butyric acid gives silage a foul smell and makes it less palatable.

FACTORS AFFECTING THE QUALITY OF SILAGE.

- The type of grass and legume species ensiled
- The stage of growth of the species ensiled
- The speed of ensiling
- The type and amount of additive used.
- Consolidation to exclude air from ensilage.
- The moisture content of the material ensiled
- The degree to which the temperature rises during ensiling.

Reasons for making silage

- For getting money
- Increase total amount of herbage produced per unit area
- Get feeds for use during periods of forage scarcity
- Conserve forage in succulent form
- Avoid forage wastage in periods of planting and abundance
- Increase number of livestock that can be kept per unit area
- Enables animals eat plant materials that they would not eat when fresh.

Advantages of silage.

- In increases the animal's appetite since it is very palatable and so increases an animal's intake of a feed.
- It is easier to store than the same quantity of hay since it requires less space per unit weight to store.
- The losses incurred during ensiling are less than those incurred in making hay.
- Many species that the animal cannot eat in fresh form can be eaten when ensiled.
- Under proper storage, silage can stay for several years without losing quality.
- Because the materials retain succulence, fire outbreaks during storage are avoided unlike in the storage of hay.
- There is increased efficiency of feed use since the animal rejects very little of the feed.

Problems of using silage.

- Some nutrients are lost due to seepage in the process of silage.
- Its more laborious
- The plant materials are difficult to compact effectively and some rotting is inevitable.
- It is expensive in terms of preservatives used.
- It requires large quantities of materials for it to be economical
- Poorly fermented silage has a bad smell that it may be introduced into the animal products.

How to reduce losses during silage making.

- Careful harvesting of the material to reduce losses of leaves and contamination by soil.
- Proper sealing of the silos to prevent re-entry of air into the silo.
- Proper fermentation of the material to exclude oxygen and acid fermentation.
- Proper chopping of the material to ensure proper fermentation.
- Wilting of the material before ensiling to reduce the moisture content and reduce the possibility of rotting.
- Addition of additives to increase the energy supply for the bacteria and preservatives.
- Quick use of the material once the silo has been opened to reduce the chances of spoilage due to exposure to the environment.

FORAGE UTILIZATION METHOD

- Continuous grazing
- Rotational grazing
- Zero grazing
- Deferred grazing.
- Strip grazing

a. Continuous grazing

This is an extensive system of grazing in which livestock remain on the same pasture for prolonged period.

Advantages of the system

i. Fencing costs are reduced or avoided completely.
ii. It allows animals to have free access to any part of the pasture
iii. No costs are involved in improving pastures.

Disadvantages

i. It allows selective grazing which can lead to pasture wastage
ii. It encourages the build up of ticks and internal parasites within the grazing place.
iii. It may result into under stocking or over stocking as plant growth and seasonal conditions change.
iv. Its difficult to control / diseases amongst animals since the system encourages communal grazing
v. Pasture improvement is extremely difficult as more people are involved in using the pasture.

vi. May easily result into overgrazing and destruction of pastures

b. Rotational grazing

This is where pastures is divided into paddocks and animals are allowed to graze in one paddock at a time until the herbage is uniformly grazed to a given height then moved to another paddock. High producers like lactating animals are allowed first into paddocks for it to graze the more nutritious herbage.

Advantages of rotational grazing:

1. Provides a uniform developed pasture due to uniform grazing
2. It allows maximum utilization of herbage by avoiding selective / spot grazing.
3. Forage yield is potentially higher since pastures are allowed to regenerate than in other systems.
4. Intervals between grazing allow for remediable practices like fertilizer application, weeding etc.
5. It's a good method used in the control of parasites like ticks, roundworms, liver fluke.
6. It reduces instances of over grazing and under grazing hence controlling destruction of pastures
7. It makes management practices easy as animals are confined in one place.
8. It allows flexibility in the use of pasture land since crops can be planted in the idle paddocks.
9. It can allow higher stocking rate of animals.
10. Controlled breeding is easy to practice since animals can be grouped according to sex

Disadvantages

1. It requires a high initial cost of establishing fences on pasture land.
2. Requires a high level of managerial skills in terms of repairing the fences, improving the pastures etc.
3. Fences can easily injure animals.
4 Over trampling on pastures by animals leads to wastage
5. May require a lot of Labour for repairing farm structures and managing animals

c. Zero grazing

This is where animals are confined in structures / stalls where they are fed on

fresh forages cut on a daily basis.

Advantages:

1. Animals are protected from adverse Climatical conditions
2. Feed taken in by each animal is easily known hence easy to keep feeding records.
3. Its easy to identify sick animals since they are in close observation
4. Its easy to collect manure from the animals since they are confined in one place.
5. Disease spread is reduced since animals are not in contact with others from another herd.
6. There is high production since animals do not spend a lot of energy looking for pasture and water
7. Selective grazing and trampling on pastures is effectively controlled since animals are fed on pastures cut from the field.
8. Its easy to carryout management practices on animals under this system as animals are under confinement.
9. The system permits high stocking rate since a large number of animals can be kept on a small piece of land

Disadvantages:

1. The method is capital intensive i.e. requires a lot of capital for constructing animal structures and feeding
2. It requires a lot of Labour which can be used in collecting fodder, cleaning the stalls etc.
3. It cannot support a large number of animals
4. The system is applicable economically in places where market for milk is readily available to cover the costs involved easily.
5. It may lead to loss of soil fertility if manure is not taken back to the fodder garden.
6. The animals lack exercise which can affect their health.

d. Deferred grazing

This is where a certain paddock is set aside to allow the accumulation of standing hay which can be grazed on during periods of pasture scarcity

1. Pasture seeds are dispersed for pasture stand improvement

2. It provides herbage during periods of scarcity.
3. It allows pastures to develop greater root and crown which is important for subsequent re-growth.
4. The pasture can be used in the control of soil erosion.
5. It allows for natural establishment of pastures

Disadvantages

i. The pasture is not as nutritious as the fresh pasture hence a need to supplement it.
ii. Requires a large piece of land for practicing deferred grazing
iii. Does not permit high stocking rates

e. Strip grazing

This is where strips of fresh pastures are made available each day to animals by moving an electric fence forward.

The grazed area is sealed off for regrowth and excess pastures conserved.

Advantages

i. The animals enjoy fresh grasses each day
ii. The grass is eaten at its highest nutritive value
iii. Allows intensive grazing hence utilizing pastures efficiently
iv. It is highly flexible since it may allow more than one activity on the land

Disadvantages

i. Requires more Labour
ii. Requires more skills in using an electric fence
iii. Pastures may be destroyed as a result of overgrazing.
iv. Ground where animals pass is destroyed and lost since pastures may fail to grow there

Establishing a pasture

a) Clear the land to remove trees and bushes that may interfere with pasture growth
b) Prepare a firm (for moisture conservation), fine (to bring small seeds in

contact with soil) and weed free (reduce competition for nutrients) seedbed by burning, ploughing, and harrowing

c) Apply fertilizers to the seed bed to improve soil fertility more especially phosphatic fertilizers for proper pasture establishment
d) Select good quality seed for planting depending on the animal's needs and environment
e) Treat the seeds to ensure uniform and proper germination by scarification, inoculation and pelleting
f) Sow the seeds shortly after the rains so as to take advantage of soil nitrogen made available by mineralization. Methods of sowing are drilling, broadcasting and row planting
g) Apply pesticides and fungicides to control pests and diseases in pastures

AGRO FORESTRY

This is the integration of trees in agriculture production

Importance of the practice

1. Trees increase out put from land in form of wood fruits, wood and fuel on top of crop and animal products
2. Trees can control soil erosion by increasing water infiltration and covering the soil surface
3. They can reduce hail damage to crops
4. Legumes improve soil fertility by fixing nitrogen into the soil
5. Rotten tree leaves improve organic matter content in the soil
6. Some trees are good source of animal feeds e.g. Lucerne
7. Trees can act as wind breaks reducing wind damage to crops and farm structures
8. Trees improve the micro climate of garden for proper crop growth
9. Some trees produce chemicals that discourage pests
10. Deep rooted agro forestry trees can recycle soil nutrients for crops
11. The mulberry tree provides food for silk worms

Adverse effects of trees in agriculture

1. Can compete with crops for soil nutrients which affects crop yield
2. Use up space meant for crops
3. Soil nutrient are lost in tree tissue as the trees are harvested
4. Some trees are poisonous to livestock and crops

5. Trees can provide habitat for pests that attack crops
6.

Factors that influence the farmer's decision to practice agro forestry

i. Availability of land for growing crops and raising trees at the same time
ii. Good land tenure system that will ensure proper tree ownership since trees take a long time to mature
iii. Availability of market for tree products within the area
iv. Clear tree ownership policy for the farmers
v. Love for trees by the farmers in an area
vi. Number of activities on the farm that may allow in tree production at the same time
vii. Knowledge of the farmer about tree management
viii. Availability of tree seeds needed for planting
ix. Enabling government policy through subsidies

Characteristics of an ideal agro forestry tree species

i. It should be multi purpose so as to be economical to produce
ii. Should be fast growing to meet the needs in time
iii. Should be deep rooted so as to recycle the nutrients
iv. Should not compete with crops for nutrients
v. Should be able to regrow fast after cutting
vi. Should be highly notorious and palatable as leaf fodder
vii. Should be preferably a legume that can fix nitrogen into the soil to improve soil fertility
viii. Should be able to produce more economic products like fruits timber and fuel
ix. Should be easy to establish and get rid of easily
x. Should have a light canopy that allows easy light penetration for the crops under it to use

Common agro forestry species and their uses

Fruit trees

Pawpaw *Carica papaya*
Mango *Mangifera indica*
Lemon *Citrus lemon*
Orange *Citrus sinesis*
Ovacado *Persea americana*
Guava *Psidium guajava*
Jack fruit *Artocarpus heterophyllus*

Shade trees

Cassia (yellow cassia) *Cassia siamea*
Cassia (golden cassia) *Cassia spectabilis*

Ficus	*Ficus spp*
Wild cassava	*Manihot glaziovii*
Tamarind	*Tamarindus indica*

Pole and timber trees

Neem tree	
Eucalyptus	*Eucalyptus spp*
Musizi	*Maesopsis eminii*
Markhamia (lusambya)	*Markhamia lutea*
Pine	*Pinus spp*

Fire wood trees

Mango
Citrus trees
Neem tree
Calliandra
Pine
Eucalyptus

Livestock feed/ fodder tree

Lucerne
Gliricidia
Calliandra
Sesbania