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(S.2 Notes from where we stopped up to term two work)

DRAINAGE

What is land drainage?

- This is the removing of excess water from land or soil in order to improve the conditions necessary for health crop growth

CAUSES OF WATER LOGGING

- Excessive rainfall
- Low evapotranspiration rate
- High percentage of clay particles in the soil which reduces water infiltration
- Development of impermeable layers on and within the soil
- Poor land scape e.g. a valley or flat area
- Excessive irrigation of the soil e.g. where flood irrigation is carried out
- High water table within the soil
- Shallow soil depth
- Poor farm planning such as unplanned layout of farm buildings

SIGNS OF POORLY DRAINED LAND

- Presence of water loving weeds
- Presence water loving soil living organisms
- Low levels of air in the soil
- Presence of water flowing on the soil surface

REASONS WHY FARMERS DRAIN THEIR LAND

- To enable the growing of a variety of crops
- To promote the activities of soil living organisms
- To expand agricultural land
- To enable the use of machines
- To control water borne diseases
- To control animal parasites e.g.liver-flukes
- To enable the utilization of labor throughout the year
- To improve soil temperature
- To improve soil aeration
- To promote organic matter decomposition

EFFECTS OF POORLY DRAINED SOIL

PROBLEMS ASSOCIATED WITH POORLY DRAINED SOIL

- It leads to flooding and submerging of crops, roads, building foundations and equipments
- It causes poor aeration leading to suffocation of roots and important soil living organisms
- Reduces soil consistence making the soil soft and unable to support buildings
- Makes mechanization impossible on the farm
- The soil becomes unnecessarily cold
- It creates a good breeding ground for vectors
- Causes soil erosion and leaching of nutrients
- Interferes with free movement of farm animals and people
- Increases disease incidences on the farm
- Reduces the economic value and use of 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 underground:-

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 buildup 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.

FACTORS THAT INFLUENCE THE CHOICE OF DRAINAGE METHOD TO USE

- Topography of the land; gently sloping areas are drained using surface drainage methods
- Cost of the method; farmers prefer cheaper methods
- The volume of water to be removed; where a large volume of water is to be removed, aerial pumping of water is done
- Climate of the area; areas with high rainfall intensity require effective methods which can remove a large volume of water in a short period of time
- Type of soil; areas with clay soil favor surface drainage

- Economic returns expected; subsurface drainage is used when high economic returns are expected
- Farmers preference; a farmer uses a method that he / she prefers
- Possession of technical skills; farmers with adequate skills use subsurface drainage
- Form of power to use; subsurface drainage is used where tractors are to be used when carrying out farm operations
- Size of land; surface drainage works best on a small piece of land

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

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

  - **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 planned.

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.

  - **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.

  - **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:

- The water droplets may have a hardening effect on the soil which hinders further water infiltration.
- The system requires a high initial capital to install which may not afforded by the peasants.
- Water does not tend to infiltrate very far into the soil more especially when pumped in small amounts.
- There is a risk of salt accumulation around the root zone areas.
- If the weather is windy, the application of water becomes uneven.

- 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 this type of irrigation.
- The system requires good quality water which cannot block the pipes.
- It is unsuitable for steep and uneven areas

FACTORS THAT INFLUENCE THE CHOICE OF IRRIGATION METHOD TO USE

- Economic returns expected; high value crops are irrigated using overhead irrigation methods
- Availability of water; surface irrigation methods require a lot of water
- Cost of installation and maintenance; farmers prefer cheaper irrigation methods
- Availability of capital; farmers with adequate money use overhead irrigation
- Size of the farm; sprinkler irrigation is the most effective for a large area
- Form of power to use on the farm; sprinkler irrigation is used when machines are to be used in carrying out farm operations
- Topography of the area; furrow irrigation is used when the piece of land is flat
- Quality of water; overhead irrigation methods are used when the water to be used is free from obstacles
- Soil type; drip irrigation is the most effective in areas that have sand soil
- Possession of technical skills; farmers with adequate skills use overhead irrigation methods
- Farmers preference; farmers with adequate skills use overhead irrigation methods

CROP PRODUCTION I

FACTORS THAT AFFECT CROP DISTRIBUTION 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 that includes;

- **Soil PH**

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

- **Soil fertility**

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

- **Soil drainage.**

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

- **Soil structure**

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

- **Soil texture**

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

- **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.

- **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.

- **Topography**

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

- **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.

- **Wind**.

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

- **Social factors**

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

- **Economic reasons**

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

- **Government policy.**

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

LAND PREPARATION

Land preparation involves all the activities that make land suitable for planting such as, ploughing/digging, harrowing, ridging, rolling etc

A piece of land that has been prepared for planting is called seedbed. In a seedbed the planting materials germinate and grow to maturity and are harvested from same place.

IMPORTANCE OF LAND PREPARATION

- To kill the weeds.
- Encourage water infiltration into the soil.
- To aerate the soil.
- Incorporate manure and other organic matter into the soil.
- To destroy stages of crop pests such as eggs, larvae, pupa or adults burying them, exposing them to the suns heat or predators and starving them.
- To encourage root penetration into the soil.
- To make subsequent operations possible e.g. planting, fertilizer application, rolling and ridging.

OPERATIONS IN LAND PREPARATIONS

They include; Land clearing, primary cultivation, Secondary cultivation, Tertiary operations.

a) LAND CLEARING

This is the removal of vegetation cover from the surface before tillage. This is done to prepare land for cultivation and as method of land reclamation. Land clearing is necessary under the following conditions.

1. When opening up a virgin land.

2. Where a stalk growing crop was previously planted such as maize.
3. Where land was left fallow for long time.
4. Where the interval between primary and secondary cultivation is long such that the land has reverted to the original virgin state.

METHODS OF LAND CLEARING

- *Tree felling*. Axes, pangas and power saws are used to cut down trees. Bulldozers and root rakers are used in felling trees on a large scale. Removal of stumps and trash later follows.
- *Burning.* The vegetation cover is set ablaze. The method should be discouraged as it destroys the soil organic matter, soil microorganisms and plant nutrients.
- *Slashing.* This is done to cut small bushes and grasses using slashers, pangas or tractor drawn mowers.
- *Use of chemicals.* Chemicals used to kill weeds are called herbicides.

b) PRIMARY CULTIVATION

This follows land clearing,

- Small scale farmers use hand hoes during hand digging.
- In Large scale framing ploughing is done using mouldboard or disc plough.
- Other farmers use ox ploughs.
- Primary cultivation should be done before the onset of the rains. This ensures that all other subsequent operations are done in good time.

IMPORTANCE OF PRIMARY CULTIVATION

- To remove weeds.
- To bury organic matter for easy decomposition.
- To facilitate water infiltration and aeration.

- To destroy soil borne pests by exposing them to predators and the sun.
- To make planting easy.

METHODS OF PRIMARY CULTIVATION

- *Hand digging.* This is done by use of hoes, mattocks and fork hoes to cut and turn the soil slices.
- *Mechanical cultivation.* This is the use of tractor drawn implements such as mouldboard and disc ploughs. Subsoilers, cultivators and chisel ploughs are used to break the hard pan. Subsoiling is the process of cultivating the soil with the purpose of breaking up the hard pan. *Use of an oxplough.* This is the use of ploughs drawn by oxen, donkeys or camels. The method is faster and more efficient than hand cultivation. It's common in areas where land is fairly flat.

Choice of the Correct Implements is determined by:

- ***Condition of the land.*** If the land has a lot of stones and stumps, a disc plough is preferred because it rolls over the obstacles without braking.
- ***Type of the tilth required.***Very fine tilth requires different types of implements.
- ***Depth of cultivation.*** When deep cultivation is required heavy implements are used. Light implements are used when shallow cultivation is needed.
- ***Topography of the land.*** Tractor drawn implements cannot be used where the slope is very steep.
- ***Implements available.*** A farmer can only use what is locally available.
- ***Shape of the land.*** Some land shapes may not allow tractor drawn implements to be used efficiently e.g. where there are acute corners.
- ***Size of the land.***

c) SECONDARY CULTIVATION

This follows primary tillage.

- This involves the refinement of the seedbed before planting.
- It is also referred to as harrowing.
- Small scale farmers can use hand hoes, fork-hoes, and garden rakes to break the soil clods and pulverize the soil.
- Large scale farmers use tractor drawn harrows such as disc harrows, spike toothed harrows, spring tine harrows.

IMPORTANCE OF SECONDARY CULTIVATION

- To remove any weeds that might have germinated immediately after primary cultivation.
- To break the soil clods into small pieces for easy planting.
- To level the field so as to obtain the uniform depth of planting.
- Incorporate organic matter into the soil in order to encourage decomposition before planting.

FACTORS DETERMINING THE NUMBER OF TIMES SECONDARY CULTIVATION IS DONE.

- *Size of the planting materials*. Small seeds require a fine tilth than large seeds.
- *Slope of the land*. If the land is hilly, less number of secondary cultivations are preferred to discourage soil erosion.
- *Moisture content of the soil*. In dry soils less operations are preferred so as to conserve the soil moisture.

- *Condition of the land after primary cultivation*. If after primary cultivation, a lot of trash is left, more harrowing operations should be carried out so as to incorporate the trash into the soil.

d) **TERTIARY OPERATIONS**

- They are carried out to meet the needs of certain crops.
- They are conducted after land clearing, primary and secondary cultivations. They include;

i. Ridging

- This is the process of digging soil in a continuous line and heaping it on one side to form a ridge (bund) and a furrow.
- These ridges are used in planting crops such as Irish potatoes, cassava, groundnuts, sugarcane.
- *They help to conserve soil and water.*

ii. Rolling

- This is done to compact the soil which is loose or of fine tilth.
- This is done to *prevent small seeds from being blown away by the wind and to prevent soil erosion.*
- This also increase seed soil contact and *ensures uniform germination of seeds.*

iii. Leveling

- This is making the soil surface flat and uniform to promote easy germination of small seeded crops.

MINIMUM TILLAGE

This is the use of a combination of farming practices that disturb soil the least. These farming practices include;Application of herbicides in controlling weeds, timing cultivation/timely weeding of the previous crop, mulching to prevent weed growth.

REASONS FOR CARRYING OUT MINIMUM TILLAGE

- Reduce the cost of cultivation. By reducing the number of operations.
- To control soil erosion.
- To maintain soil structure.
- To conserve soil moisture. Continuous cultivation exposes the soil to sun's heat hence evaporation of soil moisture.
- To prevent root and underground structures disturbance.
- To prevent exposure of humus to adverse conditions such as sun's heat that cause volatilization of nitrogen

PLANTING

Planting is the placement of the planting material in the soil for the purpose of regeneration in order to produce more of the plant species.

PREPARATION OF PLANTING MATERIALS.

After the planting materials are selected they are prepared in different ways before they are planted. Some of the methods used to prepare planting materials include the following:

- **Breaking the seed dormancy;**

Some seeds undergo a dormancy period between maturity and the time they sprout and it should be broken before the seed is planted.

- **Seed dressing;**

This is the coating of seeds with fungicides or an insecticide or a combination of the two chemicals. This is particularly common with cereals, sugar-cane and legumes. The chemicals protect the seedlings from soil-borne diseases and pests.

- **Seed inoculation;**

An inoculant is a preparation which contains the right strain of Rhizobium depending on the type of legume and encourages nodulation, hence nitrogen fixation.

When handling inoculated seeds, care should be taken to prevent them from coming in contact with chemicals. This means that inoculated seeds should not be dressed with chemicals as these will kill the bacterium. They should also be planted when the soil is moist to avoid dehydration which kills the bacterium.

TIME OF PLANTING

The timing of planting or sowing is influenced by the type of crop to be planted and the environmental conditions of the area.

FACTORS TO CONSIDER IN TIMING PLANTING.

- The rainfall pattern/moisture condition of the soil.
- Type of crop to be planted.
- Soil type.

- Market demand.
- Prevalence of pests and diseases.
- Weed control.

Timely planting is necessary and should be done at the onset of rains. In some areas where rainfall is scare dry planting is recommended.

ADVANTAGES OF TIMELY PLANTING.

- Crops make maximum use of rainfall and suitable soil temperature, leading to vigorous growth.
- Crops usually escape serious pests and diseases attack.
- Crops benefit from nitrogen flush which is available at the beginning of the rain.
- For horticultural crops, proper timing ensures that the produce is marketed when prices are high.
- Crops establish earlier than the weeds, hence smothering them.

METHODS OF PLANTING.

There are two main methods of planting;

- **BROADCASTING;**

This method involves scattering the seeds all over the field in a random manner. It is commonly adapted for light tiny seeds such as those of pasture grasses.

It is easier, quicker and cheaper than row planting. However, it uses more seeds than row planting and the seeds are spread unevenly leading to crowding of plants in some places.

This results in poor performance due to competition. Broadcasting gives a good ground cover, but weeding cannot be mechanized. For good results, the seedbed should be weed-free, firm and have a fine tilth.

- **ROW PLANTING.**

The seeds or other planting materials are placed in holes, drills or furrows in rows. The distance between one row to the other and from one hole to the other is known.

It is practiced when planting many types of crops, especially perennial, annual and root crops.

ADVANTAGES OF ROW PLANTING.

- Machines can be used easily between the rows.
- It is easy to establish the correct plant population.
- Lower seed rate is used than if broadcasting is adopted.
- It is easy to carry out cultural practices such as weeding, spraying and harvesting.

DISADVANTAGES OF ROW PLANTING.

- It does not provide an ample foliage cover. Thus the soil is liable to being eroded by wind and water.
- It is more expensive than broadcasting because of consuming a lot of labour and time.
- It requires some skill in Measuring the distances between and within the rows.

Seeds can also be planted by dibbling where the planting holes are dug by use of pangas or by a dibbling stick (dibbler).

SPACING

It is the distance of plants between and within the rows. Correct spacing for each crop has been established as shown in below.

- Maize

Spacing

75-90 cm x 23—30 cm

- Coffee

Arabica (8m by 8m) Robusta (10m by 10m)

- Tea (1.5 m by 0.75 m)
- Beans (erect type) (30cm by 30 cm) (60cm by 20cm) for row planting
- Bananas (3.6 — 6.0 m by 3.6 — 4.5 m)
- Coconut (9 m x 9 m)
- Tomatoes (Money maker) 100 x 50 cm
- kales (60 x 60 cm)

Spacing determines plant population and the main aim of correct spacing is to obtain maximum number of plants per unit area which will make maximum use of environmental factors.

Spacing is determined by the following factors:

- **The type of machinery to be used;** the space between the rows should allow free passage of the machinery which can be used in the field.
- **Soil fertility;** a fertile soil can support high plant population. Therefore closer spacing is possible.
- **The size of plant;** Tall crop varieties require wider spacing while short varieties require closer spacing.
- **Moisture availability;** Areas with higher rainfall are capable of supporting a large number of plants hence closer spacing than areas of low rainfall.
- **Use of crop;** Crop grown for the supply of forage or silage material is planted at a closer spacing than for grain production.
- **Pest and diseases control;** when crops are properly spaced, pests might find it difficult to move from one place to the other, for example, aphids in groundnuts.
- **Growth habit;** Spreading and tillering crop varieties require wider spacing than erect type.

SEED RATE.

Seed rate is the amount of seeds to be planted in a given unit area governed by ultimate crop stand which is desired.

Seeds with low germination percentage are planted at higher rates than those which have about 100% germination percentage. There is an optimal seed rate for various crops. For example, the seed rate for maize is 22 kg per hectare, wheat is 110 kg per hectare and cotton is between 17 to 45 kg per hectare.

FACTORS TO CONSIDER IN CHOOSING SEED RATES.

- **Seed purity;** pure seeds or with a high germination percentage, less seed is required. On the contrary, more seeds are required when using impure or mixed seeds.
- **Germination percentage;** Less seed is used when its germination percentage is higher. Seed of lower germination percentage is required in large amounts.
- **Spacing;** at closer spacing, more seeds are used than in a wider spacing.
- **Number of seeds per hole;** when two or more seeds are planted per hole, higher seed rate is required than when only one seed is planted per hole.
- **The purpose of the crop;** Maize to be used for silage making, for example, requires more seeds than that meant for production of grain.

DEPTH OF PLANTING.

This is the distance from the soil surface to where the seed is placed. The correct depth of planting is determined by:

- **Soil type;** seeds will emerge from grater depths in sandy soil that are lighter than in clay soils.
- **Soil moisture content;** it is recommended that one plants deep in dry soils in order to place the seeds in a zone with moist soil.
- **Size of the seed;** larger seeds are planted deeper in the soil because they have enough food reserves to make them shoot and emerge through the soil to the surface.
- **Type of germination;** seeds with epigeal type of germination (carry cotyledons above the soil surface) such as beans, should be planted shallower than those with hypogeal type of germination (leave cotyledons under the soil) such as maize.

FIELD PRACTICES

Field practices are activities carried out on the field to facilitate proper growth and maximum yield of the various crops grown.

They include the following:

- ❖ Timely seedbed preparation; it destroys weeds and pests, and improves on soil structure by giving enough time for organic matter formation.
- ❖ Proper seeds or plant material selection; only good seeds or plant materials should be selected for high crop yield.
- ❖ Early/ timely planting; it should be atthe onset of rain so that he crops get enough rain, escape pests and diseases and weeds and benefit from nutrient flush in the soil.
- ❖ Planting at recommended depth; this allows easy and uniform germination and also better utilization of soil moisture.
- ❖ Proper spacing; this reduces competition for growth factors, suppresses weeds, provides optimum plant population, and makes mechanization easy and other agronomic practices.
- ❖ Fertilizer application; both organic and inorganic fertilizers help to supplement the natural fertility of the soil so as to provide enough nutrients for proper plant growth and higher yields.
- ❖ Gap filling; filling of the empty spaces with new plants in the field maintains optimum plant population for higher yields.
- ❖ Weed control; early weeding avoids competition and destroys hiding places for pests and disease causing agents.
- ❖ Earthing up; this is the placing of heap of soil around the base of the plant. This maintains enough moisture for plant growth.

- Thinning; this is the removal of weak and unhealthy seedlings to allow enough space for remaining plants. This prevents overcrowding, competition and controls occurrence of pests and disease spread.
- Pruning; this this the removal of excess, diseased or injured branches or leaves or excess suckers from plants. This controls pest and disease spread and facilitates easy spraying and harvesting of crops.
- Controlled irrigation; this supplements soil moisture and modifies soil temperature especially during the dry season.
- Mulching; this conserves soil moisture and modifies temperature.
- Pests and disease control; pests and diseases should be controlled effectively because they lower the quality and quantity of yields.
- Timely harvesting; this reduces field losses caused by insect pests, birds, rain, thieves, rodents, shattering and germination of seeds.

HARVESTING

It is the gathering of the farm produce after maturity.

Time of harvesting depends on:

- Stage of maturity of the crops.
- use of the crop
- Tastes and preferences of consumers.
- Weather conditions, hence liability to spoilage.

Methods of harvesting is determined by:

- Scale of farming for example large scale farming machines are used.

- Type of crop for example pyrethrum is harvested by hand.
- Uniformity in ripening of the crop for example wheat is harvested by use of combined harvester while coffee is harvested by hand.
- Uniformity in height of the crop and size of seed, fruits and flowers.
- Financial status of the farmer.
- Part of the plant to be harvested.

POST-HARVEST PRACTICES

These are the preparations carried out on crop produce before it gets to the consumer. They include; Threshing/shelling, Drying, Cleaning, Sorting and grading, Dusting, Processing, Packaging.

Processing; this involves threshing, winnowing, sorting and grading up and these increases the durability of the produce.

STORAGE

Purpose of storage is to;

- Prevent spoilage
- Make the produce available for future use
- To await good market prices.

REQUIREMENTS FOR PROPER STORE ARE:

- It should be clean.

- It should be well ventilated.
- It should be raised from the ground to prevent damp conditions.
- It should be dry.
- It should be strong to hold crop produce.
- It should be easy to clean.
- It should be vermin-proof.
- It should be secure from theft.
- It should be treated against pests such as weevils.

TYPES OF STORAGE

- Traditional storage structures.
- Modern storage structures.

PREPARATION OF THE STORE

- Cleaning the store.
- Maintenance
- Dusting the store with appropriate chemicals.

Clearing the vegetation around the store to keep off vermin

NURSERY PRACTICES

Planting materials are either planted directly in a seedbed or indirectly through a nursery bed.

A seedbed is a piece of land which could be small or large and prepared to receive planting materials.

A nursery bed on the other hand is a small plot of land usually 1m wide with a reasonable length prepared for raising seedlings or planting materials before transplanting.

A seedling bed is a special type of nursery bed used for raising seedlings pricked out from the nursery bed due to overcrowding before they are ready for transplanting.

Pricking out refers to the removal of seedlings from a nursery bed to a seedling bed.

IMPORTANCE OF NURSERY BED IN CROP PRODUCTION

- To facilitate the production of many seedlings in a small area.
- It is easy to carry out management practices in a nursery than in the seedbed.
- It facilitates the planting of small seeds which develop into strong seedlings that are easily transplanted.
- It ensures transplanting of only healthy and vigorous growing seedlings.
- It reduces the period taken by the crop in the field.
- Excess seedlings from the nursery may be sold to earn income.

SELECTION OF A NURSERY SITE

FACTORS TO CONSIDER;

- Nearness to the water source.
- Type of soil; should be well drained, deep and fertile, preferably loam soil.

- Topography; it should be situated on a gentle slope to prevent flooding and erosion through surface run-off.
- Previous cropping; to avoid buildup of pests and diseases associated with particular plant families, consider the preceding crops.
- Security; select a site that is protected from theft and destruction by animals.
- Protection against strong winds and heat of the sun; select a sheltered place. I.e. to avoid excessive evapotranspiration and uprooting seedlings.

TYPES OF NURSERIES

- **Vegetable Nursery:**

  They are used for raising the seedlings of vegetable crops. They include; tomatoes, cabbages, kale, onions and peppers.

- **Vegetable Propagation Nurseries:**

  They are used for inducing root production in cuttings before they are transplanted,

  The cuttings can be planted directly in the soil and hence called bare root nurseries.

  Or planted into containers such as pots, polythene bags and others, hence called containerized nurseries.

- **Tree Nurseries:**

  These are used for raising tree seedlings. The seedlings can be raised in bare root nurseries or in containerized nurseries.

NURSERY MANAGEMENT PRACTICES:

These are the practices carried out in the nursery while the planting materials are growing.

They include; Mulching, Weed control, Shading, Pricking out, Pests and disease control, and Hardening off, watering.

PREPARATION OF VEGETATIVE MATERIALS FOR PLANTING:

The vegetative materials include; cuttings, grafting's, layering, bulbs, corms etc.

TRANSPLANTING SEEDLINGS

Transplanting of vegetable and tree seedlings are generally the same. Generally, vegetable seedlings are ready for transplanting when they are one month old or have 4 -6 leaves or are about 10-15cm in height.

Before transplanting, the nursery bed is adequately watered 3 - 4 hours before lifting the seedlings. This ensures the seedlings are lifted easily with a ball of earth around the roots to minimize root damage.

Tree seedlings take a little longer to reach transplanting age compared to vegetable crop seedlings. The roots are trimmed before lifting the seedlings.

Transplanting should be done at the onset of the long rains to give the young trees a good start.

After transplanting the young trees should be protected from damage by animals for a period of about one year.

CROP PRODUCTION II

PLANT PROPAGATION

Thisrefers to the process of deriving new plants from seeds or vegetative or is the process of increasing the number of plants of a particular species or cultivar.

It can be via **sexual** or **asexual** means.Sexual propagation involves the use of seeds to produce a new generation of plants.

A seed is a fertilized ovule and consists of plant embryo, cotyledon and surrounded by a seed coat.

On the other hand, asexual propagation involves the use of plant parts such as stems, roots and leaves.

ADVANTAGES OF USING SEEDS AS PLANTING MATERIALS.

- Seeds are easily treated against soil borne pests and diseases.
- They are not bulky therefore storage is easy.
- They are easy to handle during planting making operation easy.
- When planting seeds, it is easy to use machines like seed planters and drillers.
- It is easy to apply manures and fertilizers together with seeds during planting.
- Fertilizers and manures application can be easily mechanized.
- It is possible to develop new crop varieties due to cross pollination.

DISADVANTAGES OF USING SEEDS AS PLANTING MATERIALS.

- Some seeds have long dormancy and they may need special treatment in order to germinate.

- Plants raised from seeds have variations from the mother plant due to cross pollination,
- This may introduce undesirable characteristics.
- Soil borne pests may damage seeds if left for some time in the soil before rain falls.
- Some seeds may lose viability if stored for a long time. This leads to gaps in the farm.

SEED DORMANCY

This refers to a condition where viable seeds fail to germinate even though all the necessary conditions for germination are provided.

CAUSES OF SEED DORMANCY

- A hard seed coat (testa) that is impermeable to water and oxygen. The testa may also make the emergence of the plumule and radicle difficult.
- Presence of inhibitor substances that prevents germination of seeds e.g. abscicic acid.
- Immaturity of the seed embryos which cannot germinate when planted.
- Shortage of growth stimulating hormone like gibberellins.
- Light and temperature whereby some seeds are photoblastic and their germination are inhibited by light like onions.

WAYS OF BREAKING SEED DORMANCY

- Scarification to breakdown the hard seed coat by rubbing them between sheets of sand paper or drilling holes to allow water and oxygen entry.
- Pre chilling to expose seeds to very low temperatures for a short period of time before planting.

- Soaking seeds in cold water overnight to soften the testa before planting in normal conditions.
- Soaking seeds in growth stimulating hormones like gibberellin.
- Soaking seeds in hot water of about 80 for about 4 minutes to induce enzyme action.
- Soaking of seeds in chemicals such as sulphiric acid, potassium nitrate, and urea but then washed in water before planting.
- Ensuring the seeds are mature by harvesting them at the right time.

ADVANTAGESOF SEED DORMANCY

- It enables seeds to wait for favorable conditions before germination.
- It prevents the death of the entire population in bad times
- It allows sufficient time for the dispersal of the seed.
- It allows storage of seeds while awaiting favorable conditions for germination.
- It allows colonization of new areas.

GERMINATION is the development of a seed into a seedling.It's also known as seed viability.

It can be calculated as no. of seeds used-no. of seeds germinated*100%

Total no. of seeds

METHODS OF TESTING FOR SEED GERM INABILITY

i. THE GERMINATION TEST METHOD

Materials-seed lot, cotton wool, water, petri dish.

Procedure:

- ❖ Put the cotton wool in a petri dish.
- ❖ Pick a counted number of seeds from a seed lot at random.
- ❖ Place the seeds and cover them.
- ❖ Provide all the conditions necessary for germination.
- ❖ Continue watering the seeds.
- ❖ After about 4 days, open and count seeds that have germinated and express them as a percentage of total seeds.
- ❖ Recommend the seeds for planting if the % is 80% and above.

ii. THE LACKON TECHNIQUE (TETRAZOLIUM SALT METHOD)

Materials-seed lot, petri dish, tetrazolium salt.

Procedure:

- ❖ A counted number of seeds are soaked in a 0.1% tetrazolium salt solution for overnight.
- ❖ Remove and cut the seeds open to expose the embryos.
- ❖ Observe and select seeds whose embryos have turned pink/reddish. These are said to be viable seeds because as viable seeds respire they produce carbon dioxide that turns tetrazolium salt to pink or reddish.
- ❖ Determine the germination percentage.
- ❖ Recommend the seeds for planting if the % is 80% and above.

iii. THE POTASSIUM PERMANGANATE TEST.

Materials-seed lot, potassium permanganate solution, beaker, heat source.

Procedure:

- ❖ Put a counted number of seeds in a beaker containing potassium permanganate solution.

- Heat the seeds in the beaker for some time to break the testa so that they can release the liquid in them.
- Potassium permanganate solution is usually purple in Colour and will get discolored if the seeds are variable.

VEGETATIVE MATERIALS.

These are plant parts which have the ability to produce roots, they grow and develop in to new plants.

Plant parts such as leaves, roots or stems can be used for planting as long as they are capable of rooting.

ADVANTAGES OF USING VEGETATIVE MATERIALS FOR PLANTING.

- Crops originating from vegetative materials matures faster than those from seeds.
- The crops shows uniformity in such qualities as disease resistance, seed size, Colour, keeping or storing quality and chemical composition.
- It is possible to produce many Varieties of compatible crops on the same root stock.
- Use of the vegetative materials is easier and faster, especially where seeds show prolonged dormancy.
- The resulting plant has desired shape and size for ease of harvesting and spraying.
- It facilitates the propagation of crops which are seedless or those that produce seeds which are not viable or have a long dormancy period. Such crops include sugar-cane, bananas, Napier grass and others.

DISADVANTAGES.

- Vegetative propagation does not result in new crop varieties.
- Keeping the materials free of diseases is difficult.
- Materials cannot be stored for long.
- The materials are bulky and therefore difficult to store and transport.
- It's generally more expensive than use of seeds.
- Some vegetative materials used for vegetative propagation requires technical skills e.g. bud grafting.

METHODS OF VEGETATIVE PROPAGATION.

Natural vegetative propagation, in which plant roots, leaves or stems have been modified naturally for food storage. These include;

- Suckers; that develop from the mother plant below the ground level and can be used for planting e.g. in banana, sisal, pineapple etc.
- Splits; where individual shoots that develop in tillering plants especially grasses e.g. guinea grass, sorghum etc.
- Stem tubers; which are swollen underground stems that have buds that develop into new plants like in Irish potatoes, sweet potatoes.
- Rhizomes; these are underground stems with nodes and internodes which stores food and can grow into new plants like in couch grass.
- Bulbs; underground stems with modified leaves to store food. Have auxiliary buds which grows into new plants e.g. onions, garlic.
- Corms; these are vertical underground stems with short internodes and scaly leaves. They can be used as plant materials as it is in cocoyam.

- Crowns; that are vegetative structures which are particularly found on top of a pineapple plant.
- Bulbils; that are tinny plant produced in the inflorescence at the end of plant cycle as it is in sisal, nut grass.
- Root tubers; these are swollen underground roots that can also be used for planting e.g. sweet potatoes.
- Others include; runners, slips and Stolon

Artificial vegetative methods include;

- **Cuttings;** these are portions or parts of the plant that may be cut and used for multiplying plants. They may be stem, root or leaf cuttings. Plants such as cassava, sugarcane, apple, African violet can be multiplied using cuttings.

FACTORS AFFECTING ROOTING OF CUTTINGS.

- Temperature; cool to warm temperatures around the roots promotes rooting because of reduced transpiration. For most species optimum day and light temperatures for rooting are 22 -27°c and 15-21° c respectively.
- Oxygen supply; the rooting process requires ample supply of oxygen for respiration to release energy.
- Light intensity; soft and herbaceous plants need more light intensity for synthesizing carbohydrates. Hard wood cuttings do well in dark conditions since they have high amount of stored carbohydrates and therefore rooting is excellent in darkness.

- Relative humidity; high relative humidity prevents desiccation and encourages rooting.
- Leaf area; Soft woods cuttings require a lot of leaves for photosynthesis while hardwood cuttings will produce roots better without leaves.
- Chemical treatment; rooting hormones such as indole acetic acid, indole butyric acid promotes rooting in cuttings.

- **Layering;** this involves inducing parts of the stem to produce roots while still on the plant before they are cut off to be planted elsewhere. The part of the plant is wounded/ bent to expose the stem cambium to give rise to roots.

Layering occurs in different forms such as tip, simple, compound, air, stool/mound and trench layering.

- **Grafting;** involve uniting two separate woody pant parts of the same species to raise new plants. The lower part is called root stock, while the upper part that is grafted on to the stock is called the scion that have one or more buds to give rise to a new plant.

For successful grafting, the cambium of the root stock must be in contact with the scion cambium. Grafting occurs in many ways that includes; slice, wedge, side, saddle, notch, bud grafting etc.

- **Tissue culture**; which is also called propagules or X plants derived from shoot tips where cells are undergoing rapid cell division. The cells are provided by right conditions such as suitable growth medium containing energy sources and inorganic salts, and aseptic conditions.

Tissue culture is important in the way that it is used to recover and establish pathogenic tree plants especially in the control of viral diseases, used in massive production of propagules, and it's faster and requires less space.

When selecting materials for planting the following factors must be considered:

- Suitability to the ecological conditions;the selected planting materials should be well adapted to the soil conditions, temperatures and amount of rainfall in the area.
- Purityof the materials; planting materials should be pure and not mixed with other off types.
- Germination percentage; This helps to determine the seed rates of crops lower seed rates are used for crops with higher germination percentage while higher seed rates are used for those with lower germination percentage.
- Certifiedseeds - These are seeds which have been tested and proven to have 100 germination potential and free from diseases and pests.

CLASSIFICATION OF CROPS;

Crops are classified into two main groups

- Annual crops
- Perennial crops

ANNUAL CROPS

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

- Cereal (millet, Sorghum, Rice, Wheat, Barley, Maize, Oats, and Rye)
- Legumes (Beans, Soybeans, Cowpeas, Pigeon peg, G-nuts)
- Root Crops (Cassava, Sweet potatoes, Irish potatoes, Yams,)

- Vegetables (cabbages, tomatoes, onions, egg plants, amaranthusspp, carrots, dodo, spinach, pumpkins, cucumber, water, melon, garlic, pepper.)
- Oil crops (Simsim, sunflower, cotton)
- Fiber crops ((cotton)
- Drug crops (Pyrethrum)

PERRENIAL CROPS

- Beverages; coffee, tea, and cocoa
- Fruits; pawpaw, guava, avocado, jack fruit, passion fruit, pineapples, bananas,e.t.c
- Citrus; oranges, lemons, tangerines, e.t.c.
- Sugar crops; sugar cane and sugar beet
- Spices; vanilla, ginger, clover, e.t.c.

VEGETABLES

These are crops with high moisture content whose edible part is consumed fresh or after partial cooking.

IMPORTANCE OF VEGETABLES

- They are sources of income when a farmer decides to sell.
- They are very good source of vitamin like vitamin A and C.
- They act as appetizers for food e.g. onions and tomatoes.
- They are a good source of minerals e.g. Iron, magnesium.
- They help in controlling digestive problem like constipation.
- They allow efficient utilization of labour throughout the year.

- They can be used as animal feeds like cabbages to rabbits.
- Vegetables growing provide employment for people working as attendants in vegetable gardens.
- Vegetables are a good source of manure since they rot fast.
- Leguminous vegetables fix nitrogen into the soil e.g. beans
- They can act as cover crops hence controlling soil erosion.
- They provide raw materials for some manufacturing industries like those processing tomatoes into tomato sauce.
- Some vegetables have medical value against diseases like high blood pressure, anaemia.

CHALLENGES FACING VEGETABLE GROWERS IN EAST AFRICA

- Poor storage facilities to handle the perishable products especially in rural areas leading to rotting of produce.
- Inadequate supply of good planting materials. Some of the planting materials available have low germinability.
- Inadequate capital for purchasing tools, pesticides and quality planting seeds.
- Presence of pests and diseases that attack vegetables hence reducing their quality and quantity.
- Inadequate processing facilities for the vegetables. This makes farmers to sale poor quality and highly perishable unprocessed products.
- Limited skills and knowledge possessed by the farmers in vegetable management.
- Unclear marketing systems for the vegetables especially those in rural areas.

- Declining soil fertility levels due to continuous cropping has made the use of fertilizers expensive to vegetable farmers.
- Climate change that has brought about long dry spells and heavy storms that make vegetable management challenging and destroys vegetable gardens.
- Poor roads and unavailability of transport means to appropriately transport the products from rural areas to towns where they are demanded.

CLASSIFICATION OF VEGETABLES

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

ACCORDING TO PART EATEN

- **Leafy vegetables;** Cabbages, Amaranthus, Spinach.
- **Fruit vegetable;** Eggplant, Tomatoes, Water melon, Cucumber, Pumpkin, Okra.
- **Seed vegetables;** Cowpeas, G-nuts, Beans, Garden pea, Field pea.
- **Root vegetables,** Onions, Sugar beet, Garlic, Carrots, Irish potato.
- **Flower vegetables:** Cauliflower, Turnip, Radish.

FAMILY CLASSIFICATION

- ***Leguminosae*** **(pulse);** these include; Beans, Pigeon pea, Gnuts, Garden peas, Cowpeas.
- ***Solanaceae*** **(Tomato family);**these include: Irish potatoes, Eggplants, tomatoes, Sweet pepper.
- ***Brassicaceae*** **(cabbage family);** It includes; Cabbage, Cauliflower, Radish, Turnip, Kale.

- ***Cucurbitae* (gourd family);** Includes; Pumpkins, Water melon, Cucumber, Gourds.
- ***Alliaceae*.** This includes; Onions, Leek, Garlic.
- ***Apiaceae*.** Include; Carrots.
- ***Amaranthanceae;*e.g.** *Amaranthushybridus, A. dubius, A. caudatus.*

PROCEDURE FOLLOWED IN GROWING VEGETABLES

CHOOSING THE SITE.

FACTORS CONSIDERED WHEN CHOOSING A SITE FOR VEGETABLE GROWING

- **Fertility of the soil**: The soil should be deep and fertile. Incase at low fertility fertilizers should be applied.
- **Availability of water**, the site should have enough water supply hence the site should be close to a water source.
- **Distance from home**. The site shouldn't be far from home for security reasons and easy management.
- **Freedom from frost**: The area should be free from frost and the farmer to effect this should avoid valley bottom.
- **Freedom from shade**: The place shouldn't be having shade since some vegetable like tomato and eggplant do not thrive well in shade.
- **Topography**: Gentle slope or flat land and require for fair drainage.
- **Wind protection**: the place should be protected from strong winds.

PREPARING A NURSERY BED.

A nursery bed is an area measuring 1meterwide by any length 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.

A seed bed on the other hand is a piece of land which has been prepared and is ready to receive the planting materials where they can grow up.

TYPES OF NURSERY BEDS

- **Sunken nurseries** are prepared during the dry season.
- **Raised nurseries** during rainy season.
- **Seeds boxes** Seed boxes are wooden boxes filled with fertile soils in which seedlings are raised.
- **Soil blocks** are polythene sleeves filled with fertile soils to raise seedlings.

BENEFITS OF RAISING SEEDLINGS IN A NURSERY BED

- Many seedlings can be prepared in a small area.
- Makes it easy to carryout routine management practices.
- Provides the best conditions for growth i.e. fine tilth.
- Small seeds can be planted to develop into strong seedlings that are easy to plant.
- Ensures transplanting of healthy and vigorous seedlings.
- Excess seedlings may also provide a source of income for the farmer when sold.
- It is used in selecting healthy and strong seedlings.

- Provides conditions for raising cuttings of crops that need special treatment e.g. tea.
- It reduces time period of growing the seeds so marketing happens earlier at higher prices.

FACTORS TO CONSIDER WHEN SELECTING A SITE FOR A NURSERY BED

- **Water source:** Nearness to water sources makes watering easy.
- **Type of soil:** the soil should be deep, fertile and well drained.
- **Topography:** Gentle slopes are preferred to avoid erosion and flooding.
- **Security:** the site should be well protected from wild animals, birds and thieves.
- **Sheltering / shelter:** the site should be sheltered well with wind brakes in order to prevent the strong wind from causing damages to the seedling.
- **Previous cropping:** A nursery bed should not be made in a site where the previous crop grown belonged to the same family.

PROCEDURE OF MAKING A NURSERY BED

VEGETABLE NURSERIES

- Remove all grasses, roots and tree stumps on the area.
- The place should be cultivated deeply to encourage proper root development. oAll 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 nursery bed to a width of 1 metre and any length that you feel.
- Rake the soil to remove stones, trash and create a fine tilth.
- 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 and firm the soil to reduce chances of being eroded.
- Place the seeds in the ridges and cover it with a thin layer of soil and mulch to facilitate germination.

MANAGEMENT OF SEEDLINGS IN A NURSERY BED FROM PLANTING TO TRANSPLANTING

- Place a thin layer of mulch over the seeds to conserve soil moisture and control weeds.
- The seeds should be watered twice each day in the morning and evening.
- As soon as the seeds germinate the mulch should be removed since it may interfere with germination.
- After germination excess seedlings can be removed a practice called pricking out.
- 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.
- At a later stage before transplanting seedlings are exposed to environmental conditions referred to as **hardening off**
- 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.
- Transplanting should be done in the evening hour or morning to reduce the rate of water loss from the seedlings by transpiration. Seedlings must be watered atleast twice a day i.e. in the morning and evening**.**

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 garden should be along the contour of land to reduce erosion.

TRANSPLANTING

This is the transfer of seedlings from the nursery bed to the main field (seedbed). Precautions to be taken when transplanting seedlings oSeedlings in the nursery bed should be well watered before lifting to reduce root breaking.

- Seedlings should be lifted with soil on 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.
- Top soil and sub soil should not be mixed but filled to holes separately. - Transplant at the beginning of rain for easy crop establishment.
- Provide temporary shade to the transplanted plant (seedlings).
- Mulch around the seedling. - Continue watering until the plant has fully established itself.
- 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

- Only healthy, strong seedlings should be selected.
- Watering of the nursery to soften the soil to ease transplanting and reduce root damage.
- Transplanting should be done in the evening or in cool weather.
- Thorough preparation of the seedbed by removing all tree stamps and roots remove any other vegetation Atleast two months before transplanting.
- Dig holes before transplanting at the required spacing
- Fill the holes with a mixed top soil and double supper phosphate or organic manure Atleast 2 -3 weeks before planting.

MANAGING VEGETABLES IN THE SEEDBED AFTER TRANSPLANTING

- **Application of fertilizers.** Vegetables require more of N, P and K which should be applied early for vigorous plant growth.
- **Gapping;** the replanting of fresh seedlings in holes where seedlings failed to grow after transplanting. This is done to enable efficient utilization of soil nutrients and attain a conducive plant population in the field.
- **Weeding; Effective** weed control is needed to ensure proper growth of the vegetable since they are more sensitive to competition.
- **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.

- **Staking;** the practice of providing support to growing vegetables using poles or wires.
- **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 PREPARATION TO TRANSPLANTING

- Select a good site for vegetable production
- Remove all vegetation from the area where to prepare the seed nursery bed.
- Cultivate deeply removing all roots from the bed.
- Raise the soil level in case the soil is poorly drained.
- Incorporate well rotten F.Y.M / compost or
  S.S.P fertilizer.
- Level the soil by raking and remove any foreign material like stone, polyethene or glasses and break any big clods of soil.
- Put support side logs e.g. banana stems to protect the bed from getting washed away.
- Sow the seed at 0.5cm deep and cover lightly with soil
- Spacing should be 15cm between the rows.
- Mulch the bed lightly and remove after seeds have germinated

- Erect a shade over a nursery bed to protect seedlings from harsh environmental conditions.
- Water from the top of the shade twice a day, morning and evening using a watering can.
- When the seedlings grow up to about 2.5cm high, prick out to ensure proper spacing and growth.
- Weeding should be carried out with a garden trowel or suitable tool
- Spraying seedlings with copper fungicides such as ridomil and diethane M45 to control late blight and other pests should be done.
- As seedlings near 15cm in height, reduce the shade to ensure hardening off.
- A week before transplanting water the seedling to ensure the soil is soft to avoid breaking roots.
- A week before transplanting, remove all the shade to ensure full hardening off.
- Transplanting should be done in the evening or cloud cast day to reduce water loss from the seedlings.
- At transplanting use a trowel to remove seedling with soil around the roots.
- At transplanting use a trowel to remove seedling with soil around the roots.
- Water immediately after transplanting.

Varieties of tomatoes

Money maker, ROMA V.F, Marglobe, Heinz, Sam Marzano, Kenton F1 hybrid, Romanova.

DISEASES OF TOMATO

Tomato Blight-It's a fungal disease, it attacks leaves, stems and fruit 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

It is 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 viral 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.

It is 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

- Improves the quality of fruits by exposing each to enough light.
- Improve yields by ensuring big fruits due a reduced competition for nutrients between various branches.
- Makes spraying against disease more easily.
- Removes a micro climate that can encourage pests.
- Harvesting becomes easier since fruits are properly exposed.
- Makes movement within 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

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

CABBAGE

It is a leaf vegetable related to other brassica crops such as kales, cauliflower, Chinese cabbage and Brussels sprouts.

Cabbage leaves may be eaten raw in salads, steamed, boiled or cooked in a variety of ways.

The leaves can also be fed to livestock.

ECOLOGICAL REQUIREMENTS

- Altitude: 900-1500m above sea level those with large heads: 1800-2700m above sea level.
- Temperature: require cool condition.
- Rainfall: 750-2000mm per annum well distributed throughout the growing period.
- Soils: Deep, Fertile Well drained.

Varieties include; Copenhagen market**,** Fabiola f1**,** Blue jays f1**,** Pretoria f1**,** Golden acre, Drumhead.

NURSERY PRACTICES

- The beds should be raised, dimension 1 m wide and any convenient length (usually 2 3m in length).
- Make drills of 15-20cm apart.
- Sow seeds by drilling and cover to a depth of 1cm.
- Provide shade or mulch material.
- Apply phosphatic fertilizers and mix thoroughly with soil during planting.
- Water twice a day.

Seedbed Preparation; Cultivation should be done during the dry season so that all the weeds are killed.

Dig holes at the spacing of 60cm x 60cm. incorporate farm yard manure in the soil.

Transplanting; Water the seedlings before uprooting. Seedlings are ready for transplanting after one month that is when they are 10-15cm in height.

Select healthy and vigorous seedlings and transplant the seedlings with balls of soil to prevent root damage.

Plant to the same depth as they were in the nursery.

Pest Control

- **Diamond Black Moth**; Eats the underside of the leaf making windows or holes in the leaf.

Control: Spray recommended insecticides.

- **Cutworms**; Attacks the stem at the ground level causing the plant to fall. >**Control**: Spray recommended insecticides.

Disease Control

- **Black Rot;** Bacterial disease.

Symptoms: Leaves turn yellow and rotting of the stem giving an offensive odour.

Control: Closed season, crop rotation, use certified seeds and spray appropriate chemicals.

- **Black Leg;** Caused by a Fungus

Symptoms: Brown to black spots on seedlings and dark canker on the stem.

Control: crop rotation, destroy infected materials.

Harvesting

- Cabbages are ready for harvesting 3 4 months after transplanting.
- The heads are cut when they are solid and compact.
- Harvested cabbages are sold immediately.

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.Important cereals are wheat, rice, maize, oat, barley, rye, millet and sorghum. All cereals belong to the Gramineae family.

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

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

MAIZE - ZEA MAYS

PLANT CHARACTERISTICS

- ❖ Maize is an annual cereal crop which can grow up to a height of 4- 6 metres
- ❖ 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.
- ❖ 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.
- ❖ 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.
- ❖ In good condition maize leaves are green with parallel vein and long i.e more than 0.5m.
- ❖ At an early stage of growth it can be plough down as green manure to provide nutrient into the soil.
- ❖ 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.
- ❖ Maize flour contain a lot of carbohydrates when eaten it can be metabolized to provide energy to support the organism.

GROWTH REQUIREMENTS

- ❖ Maize requires a well-drained soil with a good supply at nutrient
- ❖ It cannot tolerate a slightest degree at water logging.
- ❖ 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.

❖ 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

❖ 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.

❖ Secondary cultivation may not be necessary since the crop has big seeds.

PLANTING AND SPACING

❖ 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

❖ 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.

❖ 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.

- 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

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

PEST AND DISEASE CONTROL

- Field Pests

i) Maize stalk borer(*Buseolafusca*)

It's the larval stage of the moth and attacks maize from the early stages of growth by making holes in leaves. In older plants, caterpillars bore into the stem and cobs.

Control

- Early planting
- Rogueing
- Burning infected maize crop remains

- Use of pesticides e.g. *Endosulfan, Diazinon, Dipterex, Malathion and Stalk borer dust*

ii) Army worm*(Spodopteraexempta*)

They are also larvae of the moths. The caterpillars are greyish-green in colour with black stripes at the back and both sides. They eat the leaves causing defoliation such that only the midribs are left.

Control

- Use of chemicals e.g. *Malathion, Diazinon*

***iii)* Aphids (*Rhopalosiphummaidis*)**

The pest sucks sap from the green husks of cobs and leaves. Attacked husks and leaves appear blackish.

Control

Use of chemicals e.g. *Diazinon, Malathion* etc.

iv) Birds.

Mainly they eat the grains at the milking stage.

Control

-Scaring them away.

- Storage Pests

i) Maize Weavil (*Sitophilus zeamais)*

It's the most serious storage pest of maize. It may also attack maize while still in the field. They make tunnels beneath the seed coat and circular holes on the surface of the grain.

Control

- ❖ Dusting with *Malathion.*
- ❖ Spraying methyl bromide onto the shelled maize
- ❖ Proper storage hygiene ie sweeping and removing old crop.

ii) Red flour Beetle (*Triboliumcastaneuum)*

Are small reddish-brown beetles, which feeds on flour and broken grains.

Control

- ❖ Proper storage hygiene

iii) Rats*(Rattusrattus)*

They attack fallen or stoked maize in the field. They are more serious however in the store.

Control

- ❖ Use of rat proof store
- ❖ Use of cats.
- ❖ Use of trap
- ❖ Use of poisoned baits
- ❖ Bush clearing around the store.

2. DISEASES

i) White Leaf Blight.

It's a fungal disease caused by a fungus called *Helminthosporiumturcicum*

It causes oval gray and thin lesions on the leaves.

Control

- ❖ Planting resistant varieties.

ii) Maize streak

Caused by virus spread by grasshoppers. The disease causes yellow longitudinal stripes, which run parallel to the mid rib.

Control

- ❖ Use of certified seeds
- ❖ Early planting
- ❖ rogueing

iii) Rust

Disease is caused by *Pucciniasorghi* and *Pucciniapolysora*

The disease forms red or brown spots on the leaves.

Control

- ❖ Planting resistant varieties

ii) Smut

It's a fungal disease caused by *Ustilagozeas*. The disease destroys grains and tassels causing masses of black powder.

Control

- ❖ Crop rotation.

Harvesting and yields

- Harvesting maize is done mechanically by combine harvester and manually by hand.
- 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.
- Maize is dried and stored in the crib i.e. a store with wall of wire netting.

LEGUMES

These are plants with root nodules which are able to fix nitrogen into the soil.Examples include bean; chickpea; cowpea; lentil; pea; peanut; soybean; and tamarind.

IMPORTANCE OF LEGUMES.

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

- 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.

- They grow in a variety of soil and can be good source of food for most of the areas.
- They require little labour and attention hence cheap to produce
- The tuber can lie in the ground until required and therefore available throughout the year.
- Most root crops are resistant to drought hence can be produced in area of little rainfall.
- Root crops are attacked by few pest and diseases as compared to other crops.

- They are able to give high yield even in poor soil hence solving the problem of hunger.

❖ 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.

❖ The cost of establishing is spread over a number of gear hence can lower than that of annual.

❖ Harvesting is continuous after establishment which reduces Labour.

❖ They may be used as security in acquiring loans from the bank.

❖ They increase value of land whenever planted.

❖ The cost of controlling pest and disease is generally lower than that of annual.

LIMITATION OF PERENNIAL CROP PRODUCTION

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

GROWING COFFEE FROM NURSERY BED TO HARVESTING

- Choose a suitable site with a good deep, well drained fertile soil from any shade.
- Plough the area a depth of 0.6m to a tilth i.e. deep ploughing
- Remove all plants roots, stones, weeds and break all big clods then level the soil using a rake.
- Incorporate manure i.e. compost manure or SSP.
- Sow/ plant seeds at a depth of 2.5m in a nursery bed at a spacing of 15cm by 15cm or 20cm x 20xm.

- ❖ Mulch and water thoroughly using watering can mulches are removed immediately after germination.
- ❖ Erect a shade to last atleast for one month.
- ❖ water regularly nursery life last for 1 ½ year
- ❖ weeding, thinning, pricking out should be done to avoid competition
- ❖ control pest and disease
- ❖ Hardening of the seedling before transplanting this is done by reducing water interval, reducing the shade.
- ❖ Only healthy, strong seedlings should be selected.
- ❖ Watering of the nursery to soften the soil to ease transplanting and reduce root damage.
- ❖ Transplanting should be done in the evening or in cool weather to reduce water from the seedlings.
- ❖ Thorough preparation of the seedbed by removing all tree stamps and roots or any other vegetation atleast two months before transplanting.
- ❖ Dig a hole two months before transplanting at a spacing of 2.7m x 2.7m and 60cm deep and 60cm wide.
- ❖ Fill the holes with a mixture of top soil and double supper phosphate or organic manure atleast 2 -3 weeks before planting.
- ❖ Top soil and sub soil should not be mixed but filled to holes separately
- ❖ Transplant at the beginning of rain after 1 ½ year when the plant is ready to leave the garden.
- ❖ Provide temporary shade to the transplanted plant (seedlings)
- ❖ Mulch around the seedling
- ❖ Continue watering until the plant has fully emerged.

Examples of coffee diseases.

- Coffee berry disease.

Its caused by a fungus, which causes brown sunken spot on the berries making them difficult to pulp.

- 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.

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

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BANANA GROWING

Scientifically bananas are classified in the Family; musacae, with genera; ensete and musa.

Bananas are perennial herbs and grow up to 5m or more. Banana is one of the major food security crops in Uganda as the crop supplies food to people almost all the time

BANANA VARIETIES

Three main groups of banana plants in East Africa:

- **The East African Highland Banana**: these are the most dominant in the region especially in Uganda. They include the cooking type (Matooke) and the brewing type (Mbidde) and these two types are physically similar.
- **The plantains**: (e.g. Gonja) these are mostly grown in the high lands of kasese in Uganda, the crop is not widely grown and is eaten roasted.
- **The cultivars of the East African coast**: these include the edible Sukalindizi dessert banana eaten ripe, kisubi a brewing type, kayinja also a brewing type and kivuvu a cooking and brewing type.

ECOLOGICAL REQUIREMENTS FOR BANANAS

- **Agro Climate**; Banana grows best at a temperature of about 27°C. The grow bananas and flowering are negatively affected at lower temperatures.

Banana grows best when they receive 1500-2500mm rain per year which is well distributed over the year. The crop grows best where relative humidity is at least over 60%.

- **Soil requirements**; Banana requires a deep, well drained loam soil with high humus content. Banana best grows in soil pH ranging from about 5.6-7.5. It doesn't tolerate acidic soil. The crop needs an adequate supply of potassium, nitrogen, magnesium, calcium and phosphorus.
- **Land preparation**: land should be slashed and prepared without burning to protect organic matter. About two ploughings are sufficient to provide a good seed bed for banana. The drainage channels or soil conservation bunds are established along the contours.

BANANA PROPAGATION

Bananas can be propagated vegetatively or by breeding. The vegetative method however is the commonest among our farmers, and you will be able to use any of these planting materials below:

- **Peepers**; these are very young suckers appearing above the ground with scale leaves only.
- **Sword suckers**; these are formed from buds or eyes low on corm and bear narrow elongated leaves, these are usually 30_60 cm tall with. These are the most preferred material as they are usually firm in the ground.
- **Maiden sucker**; these are relatively old with greater than 60cm and when are used for propagation it's advised that the leaves should be cut off to try minimize water loss.
- **Bits of large corms**; they are obtained from corms which have bared a bunch. They are dug up; the upper parts are removed and are cut in two or more pieces each containing one or more eyes.

- **Water suckers**; these are young with broad leaves and arise from the top parts of the corms. Always avoid planting these types of suckers as they are usually easy to dislodge from the mother plant and are usually weak.

Before planting, you should ensure that the suckers are clean, and free from pests and diseases.

PLANTING OF BANANAS

- The best time for planting your bananas will depend on your local climatic conditions.
- In areas with pronounced dry season and yet irrigation is not possible, you will typically plant at the beginning of the rains.
- Plant your bananas in holes dug by hand. Your banana holes should be roughly (3x2) ft, with a recommended spacing of (3x3) m
- Mix well rotten manure or compost (1-2) tins with top soil and return it to the hole.
- Put the sucker in the middle of the hole and cover with the rest of the soil.
- If you chose to use corm bits, be sure NOT to bury your corms deep; cover with just a 5cm layer of soil.

MANAGEMENT OF BANANA PLANTATION

- **Desuckering**; this involves uprooting of excess suckers from a banana mat. Removing of the side shoot is done until the emergence of flowers 1-3 stems at most per mat (i.e. the bearing one, the follower and the sucker). Sucker management is important to avoid high mats and to maintain proper spacing. High or many suckers per mat could easily fall.

- **Mulching**; this is used to conserve moisture in the soils, and to reduce rainfall runoff to avoid erosion. Mulch also improves the soil as the mulch material rots. However, mulch is known to serve as breeding place for banana weevils and other pests..
- **Staking**; Bananas are susceptible to winds and should be staked to provide extra support to the banana stems. Banana cultivars that bear very big bunches are most susceptible to heavy winds. You normally do your banana staking using a forked pole.
- **Bagging**; this involves majorly covering the banana bunch with a treated polythene bag to minimize sooty mold (Furry growth of fungus), insect damage and abrasion injury to the fruits.
- **Deflowering**; once all the fingers have developed the rest of the inflorescence including the male flower bud) should be removed to reduce incidences of fungus and insect attack.
- **Fertilizer requirements**: Bananas absorb a lot of nutrients from the soil. Therefore there is need to for you to replenish the soil using external sources like the farm yard manure, crop residues, homestead and kitchen refuse.

HARVESTING OF BANANAS

- Your bananas should mature within 3-6 months after flowering.
- Mature bananas are hard; the flower bract is dry and breaks off easily from the fruit tip.
- Harvest your banana bunches with a curved knife, or a sharp panga, you will need to cut the bunch stem carefully.

CROP PROTECTION

WEEDS AND WEED CONTROL

A weed:

Any plant growing where it is not required and whose economic disadvantages outweigh the advantages.

It is a plant out of place. Or a crop that volunteers to grow without having been planted (selfsetter).

Noxious weeds: Dangerous weeds whose cultivation is prohibited by law e.g. bhang.

Weeds Identification and classification

CLASSIFICATION

Basing on Growth cycle

- Annual weeds: Complete their life cycle in the field within a period of one year or less e.g. Mexican marigold, Black jack, Pig weed, etc.

Annual weeds are easily controlled especially before flowering.

- Biennial weeds: Complete their life cycle in two years. Achieve vegetative growth in the first year and produce seeds in the second year e.g. American wild carrot, spear thistle, ragwort etc.
- Perennial weeds: **Take** more than two years or seasons to complete their life cycle. Include: Sedges, Lantana, kikuyu grass, Wandering jew, couch grass, Sodom apple. Etc.

Plant Morphology

❖ Narrow Leaved weeds: Are grass weeds e.g. Couch, Spear, Setaria, eleusine etc. Grass weeds may be perennial or annual.

❖ **Broad Leaved weeds**: E.g. Black Jack, Oxalis, Lantana, Pig weeds, Devil's horse whip etc. May be annual or perennial.

FACTORS CONTRIBUTING TO COMPETITIVE ABILITY OF WEEDS:

❖ Produce large quantities of seeds.

❖ Remain viable in the soil for a long time awaiting conducive germination conditions.

❖ Some weed seeds are easily and successfully dispersed e.g. Fleabane (conyzaspp) has developed structures used in wind dispersal.

❖ Ability to propagate vegetatively e.g. Couch grass and Wandering Jew.

❖ Elaborate and extensive rooting system.

❖ Ability to survive where there is limited nutrient supply.

❖ Short life cycle i.e. can complete their life cycle with restricted rain regime.

HARMFUL EFFECTS OF WEEDS

❖ Compete with crops for nutrients, space, light, soil moisture therefore reduce crop yields.

❖ Parasitic to cultivated crops e.g. witch weed (striga).

❖ Lower the quality of agricultural produce e.g. Mexican marigold—gives an undesirable flavor to milk when dairy cows feed on it. Devil's horse whip, black Jack, Forget-me –not, bristly fox toilet get attached to sheep wool thus lowering its quality.

❖ Some weeds are poisonous to man and livestock. E.g. Thorn apple ,Sodom apple (when unripe)

- Some act as alternate hosts for insect pests and others for diseases e.g. Black jack for Aphids, Subukia weed, Mallow, flower of the hour etc hosts cotton strainers. Oxalis, wild oats alternate rusts disease.
- Allelopathic: Produce poisonous substances that suppress the growth or germination of cultivated plants they contact e.g. Couch grass is allelopathic to Maize.
- Block irrigation channels i.e. make it difficult for water to flow freely in irrigated land.
- Affect fishing e.g. Salvinia and water hyacinth by blocking navigation and depriving fish and aquatic animals of oxygen dissolved in water.
- Lower quality of pastures e.g. tick berry suppress pasture undergrowth. Nut grass and Manyata grass reduce palatability of herbage and carrying capacity of pasture fields.
- Irritate workers thus reducing their efficiency e.g. Double thorn, stinging nettle, devil's horse whip etc.

BENEFITS OF WEEDS TO FARMERS

- Edible to both man and livestock e.g. pig weed, wandering Jew, grass weeds etc.
- Medicinal effects e.g. Sodom apple, stinging nettle, sow thistle.etc.
- Act as soil cover, preventing soil capping due to impact of rain drops.(development of an impervious layer on the soil surface)
- Add organic matter to the soil on decomposition.
- Leguminous weeds add nitrogen in the soil.

Weed Control Methods

Include;

MECHANICAL WEED CONTROL

i) Tillage (cultivation)

- Desiccate the weeds by exposing the roots to the air.
- Buries weeds thus killing them.
- Hand tools or tractor implements are used.
- Done during dry season to ensure better drying of weeds.
- Weeds are destroyed before they produce seeds to break their life cycle.

ADVANTAGES OF TILLAGE IN WEED CONTROL

- Cheap and therefore good for small scale farmers.
- Allow infiltration of water thus minimize soil erosion.
- Earthing up is done during tillage which encourages root growth.
- Crop residue is incorporated in the soil during tillage.

DISADVANTAGES

- Pulverizes the soil thus destroying soil structure.
- Creates suitable conditions for weeds to germinate.
- Laborious and expensive in large scale.
- Leads to water loss, soil erosion and damage to crop roots.
- Does not effectively control perennial weeds.

ii) Slashing (mowing): Is the mechanical removal of shoots from weeds especially annual weeds when done repeatedly.

iii) Uprooting: Done where weeds are scattered or where crops are too close to allow mechanical cultivation.

CULTURAL WEED CONTROL

Are crop husbandry practices carried out on the farm without use of chemicals.Include:

- **Mulching:** smothers weeds thus preventing weed growth.
- **Cover cropping**; Smother the weeds.
- **Crop rotation**: Weeds associated with certain crops will not germinate or grow when rotated e.g. striga in cereal crops and sugar cane.
- **Use of clean planting materials**: Prevent introduction of weeds into the farm.
- **Proper spacing**: Creates little space for weed growth or form a canopy which suppresses weeds.
- C**lean seed bed:** Starts off crops on clean bed to effectively compete with weeds.
- **Flooding:** Discourages growth of all non aquatic weeds.

BIOLOGICAL WEED CONTROL:

Is the use of living organisms to control weeds.

Include:

- Use of livestock: e.g. goats in coconut and cashew nut plantations.
- Use of certain weed eating fish to control aquatic weeds
- Use of Moths to control cacti.
- Beetles to control water hyacinth.

ADVANTAGES

- Cheap.
- Not poisonous or pollute the environment.
- Less laborious.
- Does not kill soil micro-organisms.
- Does not destroy soil structure.

LEGISLATIVE WEED CONTROL:

Involves government laws and acts which prevent the introduction of noxious weeds in a country or the spreading of certain weeds from one part of the country to another.

Imported materials such as seeds, food and clothes are tested to certify they are weed free.

Limitations:

- Enforcement of laws is difficult.
- Only sample of materials are checked while the bulk of the material may have some weeds.

Noxious weed law; requires noxious weeds to be destroyed or not cultivated e.g. bhang (cannabis sativa).

CHEMICAL WEED CONTROL:

Herbicides are the chemicals used to control weeds.

WAYS IN WHICH HERBICIDES WORK TO KILL THE WEEDS.

- **Inhibition of nitrogen metabolism:** some interfere with nucleic acids (D.N.A, R.N.A) e.g. Atrazines which increase or reduce nitrogen metabolism. Glyphosate interfere with enzyme functions.
- **Kill the cell:** The herbicides penetrate the cell wall, destroy it and enter cell cytoplasm, killing the cell e.g. Diquate, dinosel and oils. These are contact herbicides.
- **Causing abnormal tissue development:** Include twisting, gall formation. Some herbicides interfere with plant growth e.g. phenoxy acetic acids, benzoic acids, 2, 4-D and M.C.P.A.
- **Inhibiting photosynthesis:** Some herbicides interfere with chlorophyll formation e.g. Atrzines, Simazines, Duron, Linuron, and Uracils.

❖ **Inhibiting Respiration:** some herbicides block movement of materials from the site of manufacture to other areas. They therefore cause acute poisoning e.g. Dinozebs.

CLASSIFICATION OF HERBICIDES

Include:

i) Formulation

Is the physical form of herbicides e.g.

❖ Liquids: are soluble in water or oils. Are highly concentrated or toxic e.g. dalapon, paraquat.

❖ Wettable powders: Finely ground particles. Form suspensions with water before application. A spreader is applied in the suspension to prevent flocculation. Constant agitation of the particles also avoids clustering. Include: atrazines, simazines and duron.

❖ Granules: Granule form. Control water weeds e.g. duron.

ii) **Time of application: w**hen applied at different stages of weed growth, herbicides are effective. Include:

❖ **Pre-emergence herbicides**: Are applied soon after crop seeds have been sown but before they emerge. Kill the germinated weeds such that crops germinate in a weed-free environment. Include: atrazines and simazines.

❖ **Post-emergence Herbicides: Are** applied after crop germination or transplantation or at different stages of crop growth. Include; 2,4-D, M.C.P.A, paraquat, Glyphosate etc.

iii) Mode of Action:

Include:

- **Contact Herbicides: Ki**ll only the parts of the plant with which it comes into contact.
- **Translocated Herbicides/Systemic: K**ill the whole plant even if it comes into contact with only a small part of it i.e. they are absorbed into the plant and translocated to all parts of the plant.

iv) Environmental factors: Affect effectiveness of herbicides.

Include:

- **Wind:** blow away splash wash to unintended places while decreasing chemical concentration to the intended places.
- **Rain:** Dilute or wash away the chemical to non-toxic levels. Leaches and reach herbicides to roots of deep rooted plants thus killing them.
- **Soil:** some absorb and retain more herbicides than others and therefore require more doses to be effective.
- **Light:** Increase in light intensity increases the rate of light of light absorption and photosynthesis by plants hence increasing absorption and translocation of herbicides and therefore causing faster killing of plants. Some herbicides are decomposed by high light intensity hence become less effective.
- **Temperature**: increase translocation hence absorption of more herbicides and therefore death of plants.

v) Selectivity

Include:

Selective herbicide: Injures one plant and allows the other to escape injury. Selectivity of herbicides depend on susceptibility and tolerance of each plant species.

Non-selective herbicide: Injures all kinds of plants because it interferes with photosynthesis.

FACTORS AFFECTING SELECTIVITY AND EFFECTIVENESS OF HERBICIDES

- **Stage of growth of the plant:** young plants are more susceptible to herbicides action because of their high growth activity.
- **Physiological/metabolic factors:** beans have a poor rate of translocation of 2,4-D. maize is able to neutralize the toxic levels of 2,4-D to less toxic 2,4-B.
- **Herbicides characteristics:** Herbicides which interfere with photosynthesis are non- selective.
- **Concentration:** Under high concentration herbicides kill all kinds of plants.
- **Formulation:** Oil formulations are more toxic to plants.
- **Method of application;** High selectivity is attained by placing the herbicide where the weed is and away from the crop.
- **Plant morphology and Anatomy:**

Morphological and anatomical characteristics of weeds that affect selectivity:

- **Leaf angle:** Leaf angles which are inclined e.g. grasses are less susceptible as compared to horizontal angles such as dicots.
- **Nature of leaf surface**: Plants with thick and waxy cuticles and surfaces retain less herbicides e.g. cactus, wandering jew.
- **Differential heights of the plants:** Shorter weeds than crops or shorter crops than weeds, selectivity are attained e.g. spraying weeds under coffee bushes.
- **Location of growing points**: Dicots are more susceptible to herbicides because their growing points and terminal buds are more exposed than in grasses.
- **Difference in rooting system:** Shallow rooted plants are more susceptible to herbicides than deep rooted which require herbicides with long residue effect.
- **Specialized structures:** Plants with underground structures such as rhizomes and bulbs e.g. sedges and oxalis are not easily killed by herbicides.

SAFETY PRECAUTIONS IN USE OF CHEMICALS

- Read manufacturer'sinstructions.
- Wear protective clothing e.g. overall, breathing masks, gloves, and boots.
- Avoid inhaling herbicide i.e. not spray against wind, not smoke and wear a breathing mask.
- Bath thoroughly after handling the chemical and not eat before bathing.
- Do not unblock blocked nozzles by blowing with the mouth.
- Avoid spraying against the wind/not spray on windy days.
- Avoid spilling herbicides on pastures and fodder crops.
- Dispose of empty containers and left overs e.g. by burying them.
- Do not wash spraying equipment in water sources used by livestock and humans.
- Store chemicals out of reach of children and away from food.
- Wash equipment thoroughly.

ADVANTAGES OF USING HERBICIDES

- Require less labour than mechanical cultivation.
- Adapted to control of bothersome weeds e.g. Couch grass and sedges.
- Does not disturb crop roots and underground structures.
- Makes control of weeds in certain crops easier e.g. wheat, burley, carrots.
- Efficient in both wet and dry soil conditions as compared to mechanical cultivation.
- Maintains soil structure.
- Convenient to use in certain crops e.g. sisal and sugarcane and weeds such as double thorn and stinging nettle which injure farmers.
- Cheaper than manual or mechanical cultivation (on large scale farming).

DISADVANTAGES

- Require skilled labour in mixing and application.
- Poisonous to environment and the user.
- Some herbicides have long residue effects (pollutes environment).
- Expensive—Uneconomical in small scale.

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.gThrips, 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

- ❖ Pest population; high population requires immediate intervention
- ❖ Reproductive rate of pests; high rate of reproduction may mean high pests population in a short time
- ❖ Part of crop affected; pests that attack vital parts of a crop like flowers must be controlled immediately
- ❖ Crop response to attack; when a crop shows a high response, then control must be immediate
- ❖ Feeding habits of pests; biting and chewing pests cause a lot of damage hence must be controlled immediately
- ❖ Presence of pest predators; once a pest has predators, artificial control may not be necessary.
- ❖ Weather conditions; harsh weather may not favour pests hence in such conditions control may not be necessary
- ❖ Pest mobility; highly mobile pests like those that fly can spread fast hence control is urgent
- ❖ Presence of alternate plants; during control, alternate hosts must be eliminated as well.
- ❖ 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

- ❖ Should have good knowledge of pest classification and behavior
- ❖ Make good pest sampling techniques
- ❖ Should have good knowledge about pest predators

- Know the type of food eaten by the pest
- Know the pest habitat
- Know the stages of pest development
- Consider economic damage of the pest
- Control pests at the favorable weather conditions

MECHANICAL METHODS

- *Use of lethal temperature*.
- *Suffocation*. This is used in the Cyprus bins where CO2 is introduced to suffocate pests.
- *Flooding*. This can be used c to control pests such as armyworms and cutworms. Moles can also be killed through flooding.
- *Proper drying of the produce.* This makes grains hard for pests to penetrate and discourages the3 growth of moulds. Grains should be dried up to a moisture content of 12%
- *Physical destruction of pests.* Hand picking and trapping can be used to control pests.
- *Use of scarecrows.* They scare large animals and birds out of the farm.
- *Use of physical barriers.* They include use of fences to control large animals and rat proofing in stores.
- *Use of electromagnetic radiation.* Some wavelengths of electromagnetic radiations can be used to deactivate enzymes in some insect pests. Some pests are attracted by certain wavelengths such as moths are attracted by ultra-violet rays and aphids by yellow light.

Once attracted, heat or chemicals can then be used to destroy them.

X-rays can also be used to control some storage pests.

CULTURAL METHODS.

This is the use of all the good farming practices to minimise and discourage pests from attacking the crops. Cultural practices do not eradicate or kill pets but alter the environment for pest's survival and discourage pest attack. These practices include the following.

- *Tillage.* This exposes soil borne pests to their natural enemies or exposes them to the hot sun, which kills them.
- *Weed control.* Some weeds act as alternative hosts to crop pests. Removal of such weeds reduces pest infestation.
- *Early planting.* This enables crops to establish earlier before pests multiply to large numbers.
- *Burning of crop residue.* This destroys pests and their eggs reducing further attack on the next crop.
- *Crop rotation.* This interferes with the life cycle of pests reducing their population
- *Use of clean planting materials.* This ensures that no pests or their eggs are introduced into the field.
- *Planting resistant crop varieties.* E.g. goose necked sorghum reduces attack by birds.
- *Closed season.* This is where a particular crop is not grown for a season to control a particular pest such a not growing maize to control maize stalk bores.
- *Crop nutrition/application of fertilizer*. This encourages vigorous and healthy growth of crops, which can tolerate and escape pest attack.
- *Pruning.* This discourages conditions, which may favour the breeding grounds of pests in crops.

- *Timely harvesting.* Crops can be harvested at the right time to avoid pest attack e.g. overripe fruits encourage attack by fruit flies.
- *Proper spacing.* This discourages quick spread of pests.
- *Growing of trap crop.* This is the growing of a crop to trap certain crop pests either before or at the same time with the main crop.
- *Irrigation.* Overhead irrigation controls aphids in cabbages.

CHEMICAL CONTROL.

This involves the use of pesticides to control pests. Pesticides influence the pets in three ways.

- By direct poisoning.
- By inhaling.
- By ingesting.

The pesticide used should be

- Efficient
- Selective
- Cheap
- Persistent
- Safe to the user and the environment.

CLASSIFICATION OF PESTICIDES

- *Formulation.* E.g. soluble powders, wettable powders, fumigants, dust, liquids, granules, emulsions etc.
- *Target pest.*
  - ✓ Insescticides
  - ✓ Nematocides
  - ✓ Rodenticides.

✓ Fungicides.

❖ *Mode of action.* They may be classified according to the way they function into the following.

✓ *Stomach poisons.* These only kill those pests, which consume the sprayed crop with the chemical, hence are selective.

✓ *Systemic poisons.* They are circulated to all parts of the pest once it has eaten the sprayed part of a plant.

✓ *Contact poisons.* They kill the pests when they are absorbed in the body through the skin or cuticle. They are not selective and may kill many beneficial organisms such as predators, pollinators, decomposers, birds etc.

✓ *Suffocants.* They kill by interfering with the breathing system after being inhaled.

✓ *Anti-feedants.* They inhibit feeding on insects and other pests thus starving them to death.

✓ *Repellants.* They keep the pest away from the plant.

FACTORS AFFECTING THE EFFICIENCY OF PESTICIDES

❖ *Concentration.* Correct concentration should be used when diluting the pesticide, as it is the most effective.

❖ *Timing of Application.* They should be applied at the stage of development when the pest is most susceptible to the pesticide.

❖ *Weather conditions at the Time of application.* If the rain falls immediately after application of a pesticide, it may wash off or dilute the pesticide thereby reducing its effectiveness.

❖ *Persistence.* If a pesticide can remain effective for long, then the better. This ensures that more pests can be controlled.

ADVANTAGES OF CHEMICAL CONTROL

- ❖ Method is faster compared to other methods such as crop rotation, field hygiene etc.
- ❖ Most pesticides have rapid knock-down effect hence the method is more reliable and predictable.

DISADVANTAGES

- ❖ Expensive.
- ❖ Most are not environmental friendly since they are toxic to man and livestock
- ❖ They require care and skill when handling and applying them.
- ❖ Most are non-selective and therefore they kill useful insects such as pollinators and predators.
- ❖ Pests establish resistance to pesticides if they are used continuously against them. E.g. DDT.

BIOLOGICAL PEST CONTROL

This involves the use of a living organism, which is a natural enemy of the pest.

Predator	*Aphids*
Ladybirds	*Aphids*
Wasps.	*Coffee mealy bugs*
Majimoto ants	*White scales*
Chicken	*Cotton stainers.*
Cats	*Moles, rats and mice*

Chameleons.	*Most insects*
Praying mantis.	*Giant loopers*

The method is environmental friendly but it can be very slow.

CROP DISEASES AND THEIR CONTROL

DISEASE

It is a condition that interferes, impairs or disturbs the normal performance of an organism.

A disease is a deviation from good health.

Harmful Effects of Crop Diseases

- Lowers crop yield.
- Poor quality products hence reduced market value.
- They cause food poisoning by producing toxic substances such as *Aspergillus flavus* in maize produces *Afflatoxin*; *Ergot* in wheat and barley causes nerve endings.
- Increase the cost of production.

CLASSIFICATION OF PLANT DISEASES

a)FUNGAL DISEASES

They are either parasitic or saprophytic. This gives rise to the following categories.

- *Obligate parasitic fungi*. They completely depend on other living organisms for food. They are found in plant parts such as leaves, roots, stems, fruits etc.
- *Facultative parasitic fungi*. They can live on both the living and dead tissues.
- *Saprophytic fungi*. They live as decomposers on dead decaying plant and animal remains. They are beneficial in nutrient recycling.

Examples of Fungal Diseases

1. Late Blight

- Caused by *Phytophthorainfestans* .the disease affects most members of the *solanaceae* family such as Irish potatoes and tomatoes.
- The fungi are parasitic and feeds by sending short *hyphae* called *haustoria* into the cells of the host.
- Haustoria absorb plant nutrients (manufactured food) from the plant cells resulting in the death of the cell.
- The fungi reproduce by spore formation, which are dispersed by wind and raindrops.
- It spreads very quickly during warm moist conditions.

Symptoms

- Rapid drying of the leaves forming dry patches (necrotic lesions) on leaves and fruits.
- Affected fruits appear rotten and fall off prematurely.

Control

- Spraying with Bordeaux mixture and other copper based fungicides.

2. Rusts

- Cause – Puccinia spp.

- ❖ They attack the leaves and stems of most cereal crops.
- P. Sorghi - sorghum
- P. graminis. Maize

Symptoms

- ❖ Infected leaves have red to brown pustules hence reduced photosynthetic are and low yields.
- ❖ Crops appear rusty.

Control

- ❖ Spraying with Bordeaux mixture and other copper based fungicides

3. **Smuts**

- ❖ Cause – Ustillago spp.
- U. scitiminea – sugar cane
- U. nuda - wheat
- U. maidis - Maize.

- ❖ This produces large number of black spores, which forms black masses on maize tassels and maize cob.

Control

- ❖ Hot water treatment of the seeds.
- ❖ Use of certified seeds
- ❖ Crop rotation.
- ❖ Field hygiene e.g. rogueing and proper disposal of previous crop residue.

4. Coffee Berry Disease (CBD)

- ❖ Cause – *Colletotricumcoffeanum*.
- ❖ It attacks the flowers, leaves and berries.
- ❖ Flowers and leaves have dark brown spots.

- Spots on leaves develop along the margin and later spread to the rest of the leaf causing defoliation.
- The disease attacks both green and ripe berries.
- Attacked green berries fail to form beans and are hollow.
- Attacked ripe berries have sunken wounds and are difficult to pulp/process.

Control

- Spraying with appropriate copper based fungicides.
- Open pruning.
- Resistant varieties e.g. Ruiru 11.

Other Fungal Diseases

- Damping off. *Pythium spp.*
- Powdery mildew.
- Root rots – *Armillaria spp*.
- Downey mildew – *Peranospara spp*.
- Early blight – *Alternaria spp*.
- Anthracnose – ***Colletotricumlindemuthianum***

b)VIRAL DISEASES

- All viruses are parasitic and very small.
- They are only able to reproduce and multiply in living tissues.
- When outside living tissues, they form spores in cysts, which remain inactive until they get into a living tissue.
- They are therefore obligate parasites. Viral infections interfere with important life processes of plant such as photosynthesis, respiration, transpiration, and nitrogen utilisation.

Symptoms of Viral infections

- ❖ Leaf chlorosis – loss of chlorophyll.
- ❖ Leaf curling.
- ❖ Mosaics – production of light green patches on leaves.
- ❖ Malformations (distortions) of plant parts e.g. galls (swellings), small leaves etc.
- ❖ Rosetting –production of abnormally short nodes hence stunting.

NB/Insect vectors such as aphids and mealy bug transmit viral diseases. Infected vegetative parts such as sugar cane cuttings also transmit viral diseases.

Examples of Viral diseases

- ❖ Maize streak. – Formation of white/yellow stripes on leaves parallel to midrib.
- ❖ Greening disease – attacks leaves of citrus.
- ❖ Tristeza – attacks citrus trees. The leaves fall off and there is dying of twigs.
- ❖ Cassava mosaic -
- ❖ Brown streak of cassava
- ❖ Potato leaf roll
- ❖ Tobacco
- ❖ Groundnut rosette.

Viral diseases are controlled by controlling the vectors.

c)BACTERIAL DISEASES

- ❖ Bacteria are facultative parasites. They are single celled and microscopic. Not all bacteria are harmful.
- ❖ Some are beneficial to man e.g. *Rhizobium spp* which is a nitrogen fixing bacteria.

- They may be transmitted through insects, wind, raindrop splashes, manures, seeds, irrigation water, cultivation implements and pruning knives.
- They enter plants through openings such as stomata, lenticels and wounds.

Symptoms of Bacterial Diseases

- Wilting even when water is in adequate amount due to blockage of xylems.
- Cankers – results into the death of plant tissues.
- Gall formation in the infected tissues.

i) Bacterial Blight of Coffee (BBC)

Cause – *Pseudomonas syringe.*

Bacteria enter plant through wounds and natural openings. It's common in areas experiencing hailstorms.

Symptoms

- Dark necrotic lesions with water soaked margins on affected parts.
- Shoot die back.
- Cankers on mature bark and wood killing the whole plant.

Control

- Spraying chemical eg. Supanil, before, during and after the flowering periods especially during the wet weather.

ii) Bacterial wilt (*Pseudomonas solanacearum*)

- Attack potatoes, tomatoes and other *solanaceae* plants
- Affected plants wilt even when the soil is moist.
- Leaves droop and plants eventually die
- High temperature accompanied by wet conditions favour the disease.

iii) Black arm of cotton

iv) Black rot of cabbage

v) Halo blight of beans

d) Nutritional disorders

When crops do not get enough nutrients, deficiency symptoms appear eg

- ❖ Yellowing of leaves
- ❖ Drying of leaves
- ❖ Falling of leaves, flowers and fruits
- ❖ Stunted growth
- ❖ Death.

e) OTHER CAUSES

I. Flooding. During flooding ammonia may be formed.Since ammonia is toxic, it has burning effect to plants.

II. Chemical. Toxic chemical compounds in the soil may be absorbed by the plants leading to death of the plant eg. Cyanides.

III. Poor weather.Extreme day and night temperature may be injurious to the crop. Eg very cold temperature causes frost injury in tea.

IV. Stress. Stressful conditions on the plant such as irregular watering may causes physiological disorders such as blossom end rot in tomatoes.

CONTROL OF CROP DISEASES

a) Cultural methods

This involves the use of crop husbandry practices that discourages the outbreak of diseases without the use of chemicals. They include;

- ❖ Planting resistant crop varieties that can withstand the effect of certain diseases without lowering the yields eg line1- IV are coffee varieties resistant to CBD.
- ❖ Practicing proper spacing of crop. Overcrowding results to quick spread of diseases.
- ❖ Use of health planting materials. Some diseases are seed borne and can effectively be controlled by use of artificial seeds for planting.
- ❖ Practicing field hygiene eg burning of crop residue destroying infected plants etc.
- ❖ Drying of cereals and pulses to a moisture content of 12 – 13% before storage. This discourages attack by moulds (fungi)
- ❖ Heat treatments of some planting materials eg treating sugar cane cutting with water at 50^0c for 30 minutes control ratoon stunting disease effectively.
- ❖ Proper pruning of crop destroys the micro- climate that may have encouraged buildup of diseases causing organisms.

b) Chemical control

Chemical control should be practised only when all other methods have proved to be ineffective and when it'seconomical.Chemical control measures include:

- ❖ Seed dressing

This is the application of fungicides before planting seeds.

The fungicides prevent attack on the planted seeds.

- ❖ Spraying

This is the application of chemical such as fungicides using a sprayer.

- ❖ Soil fumigation.

This is the application of chemical (fumigants) in the soil. The chemical are usually in dust or granule form and are mixed with the soil to kill soil borne diseases causing organisms in the soil eg in the control of Bacterial wilt in potatoes.

Advantage of chemicals

- Chemical act faster in controlling diseases.(effective)
- Chemical requires less labour in application.

Disadvantages of chemicals

- Expensive
- Requires skills in application
- Toxic to humans and livestock
- Pollutes environment
- Some do not break down easily

c). Legislative method

This involves imposing of regulations and laws in cases of diseases outbreaks to prevent the introduction and spreading of diseases.

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.

AIMS OF CROP BREEDING / IMPROVEMENT.

- To increase crop yields so as to save the problem of hunger and food shortage.
- To increase the nutrient content of the crop product to solve nutrient deficiency in consumers.
- Produce better size and colour of fruits / seeds that can attract consumers.
- To reduce the gestation period of a crop so as to solve food shortage.
- Conferring disease and pest resistance in crop.
- Production of crops that can tolerate adverse environmental conditions like drought, low soil fertility, high temperature.
- To change growth characteristics of a plant in order to suit harvesting spraying and weeding.
- to improve on the short life of the sowed crop production
- To improve on seed viability character in plants so that there is no wastage of seeds during planting.
- Improving the taste and flavour of certain crop products.
- To produce crop products that is easy to prepare as food for consumers.

METHODS OF CROP BREEDING

- **MASS SELECTION**

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

- **BULK BREEDING**

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

- **PEDIGREE BREEDING**

This is the most used method and it's based on the performance of the ancestor and close relatives.

- **SINGLE DESCENT**

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

- **RECURENT SELECTION**

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

END OF S.2 TERM TWO NOTES