

## **CHAPTER ONE: PHYSICAL PROPERTIES OF THE SOIL**

### **WHAT ARE THE SIX PHYSICAL PROPERTIES OF THE SOIL?**

**Soil has the following** physical properties which provides vital medium for plant growth

#### **1. Soil texture**

Soil texture is defined as the proportion of sand, sit and clay in the soil

#### **2. Soil Consistency**

#### **3. Soil structure**

Soil structure is defined as the arrangement of soil particles such as clay, sand and silt to form aggregate or collections.

Soil structure can also be defined as the arrangement of soil particle (sand, silt, clay and organic matter) into granules, crumbs or blocks.

#### **4. Soil porosity**

#### **5. Soil temperature**

#### **6. Soil colour**

### **SOIL TEXTURE**

- Soil texture is defined as the proportion of sand, sit and clay in the soil.
- Soil texture refers to the proportion of sand, silt and clay sized particles that make up the mineral fraction of the soil.

### **CLASSES OF THE SOIL TEXTURE**

-These include

1. Sand soil- This has more than 70% sand particles
2. Clay soil- This has over 40% clay particles
3. Loam soil : This has almost equal proportion of sand and clay

### **HOW TO COMPARE WATER HOLDING CAPACITY OF THE THREE CLASSES OF SOIL TEXTURE**

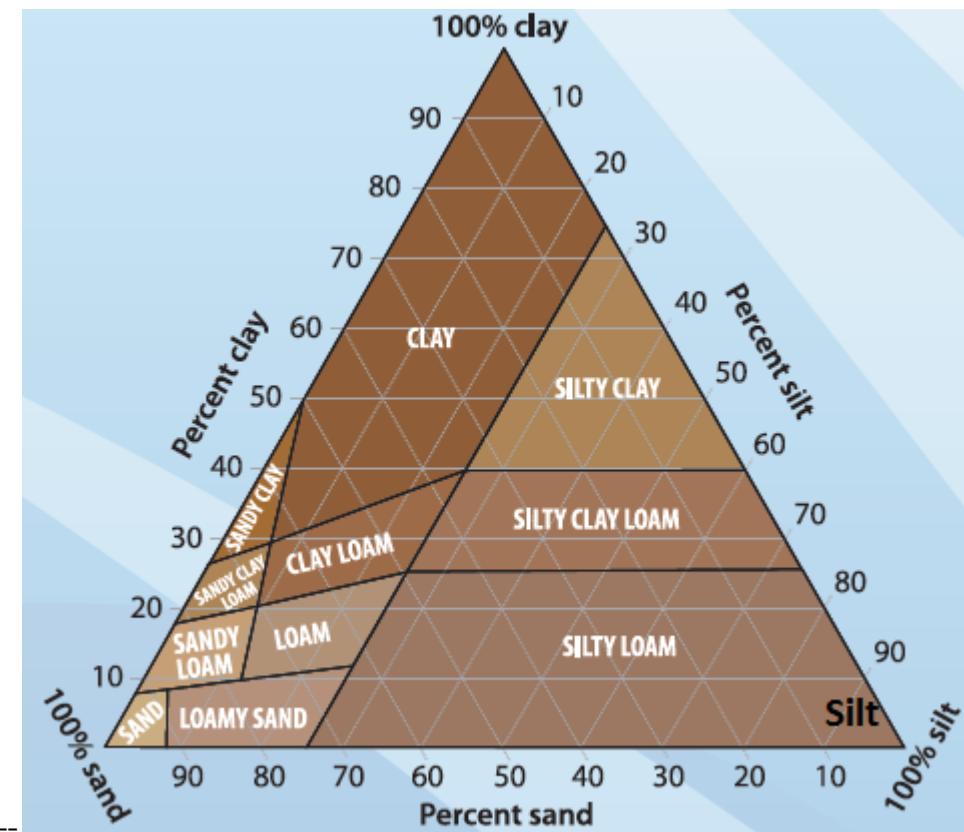
The following are the procedures that need to be followed when comparing water holding capacity of the three classes of soil texture

1. Set up three measuring cylinders with funnels.

2. Weigh about 20 g each of sand, clay and loam soil.
3. Put the samples in the funnels of the measuring cylinders and label them A, B and C.
4. Pour 50ml of water into each of the funnels.
5. Observe the water as it drains and stops coming through.
6. Record the time when the first drop of water comes through the funnel

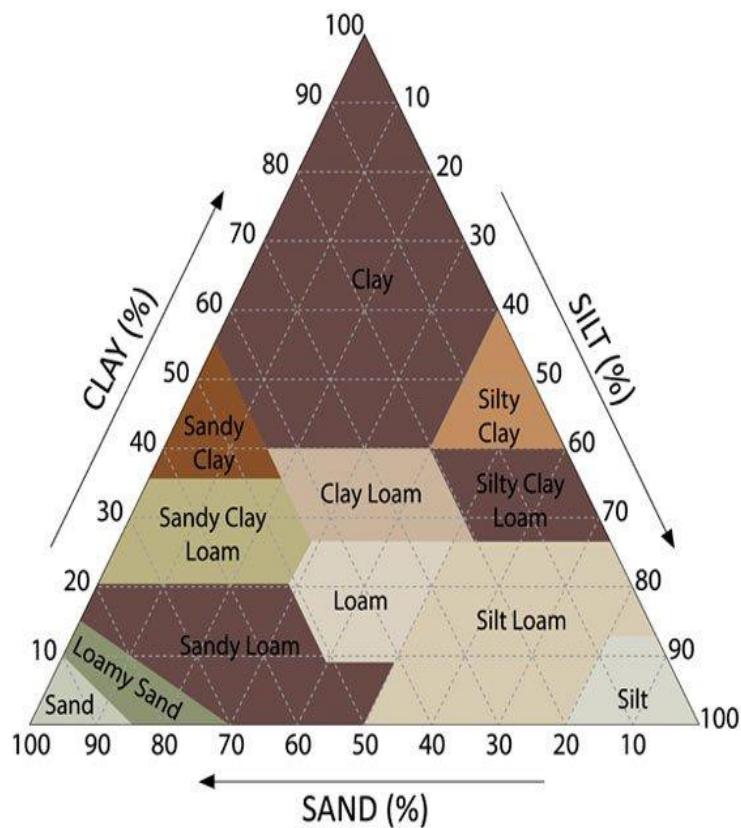
### **SOIL TEXTURE TRIANGLE**

- The soil texture triangle is one of the tools that scientists use to visualize and understand the meaning of soil texture names.
- Soil triangle is a tool that can be used to determine the name of the soil if the percentages of sand, silt and clay are known. Scientists use the approximate ration of sand, silt and clay to categorize soils and give their names



- Soil triangle chart is used to read the percentages of each of three ingredients [the combination of sand, silt, and clay]. It is illustrated as a triangle. Each side of the triangle represents the amount of an ingredient.

- The **soil texture triangle** gives names associated with various combinations of sand, silt and clay. A **coarse-textured** or **sandy** soil is one comprised primarily of sand-sized particles. A **fine-textured** or **clayey** soil is one dominated by tiny clay particles. Due to the strong physical properties of clay, a soil with only 20% clay particles behaves as sticky, gummy clayey soil. The term **loam** refers to a soil with a combination of sand, silt, and clay sized particles. For example, a soil with 30% clay, 50% sand, and 20% silt is called a sandy clay loam.
- The textural triangle is a diagram which shows how each of these 12 textures is classified based on the percent of sand, silt, and clay in each as shown in the triangle chart below:

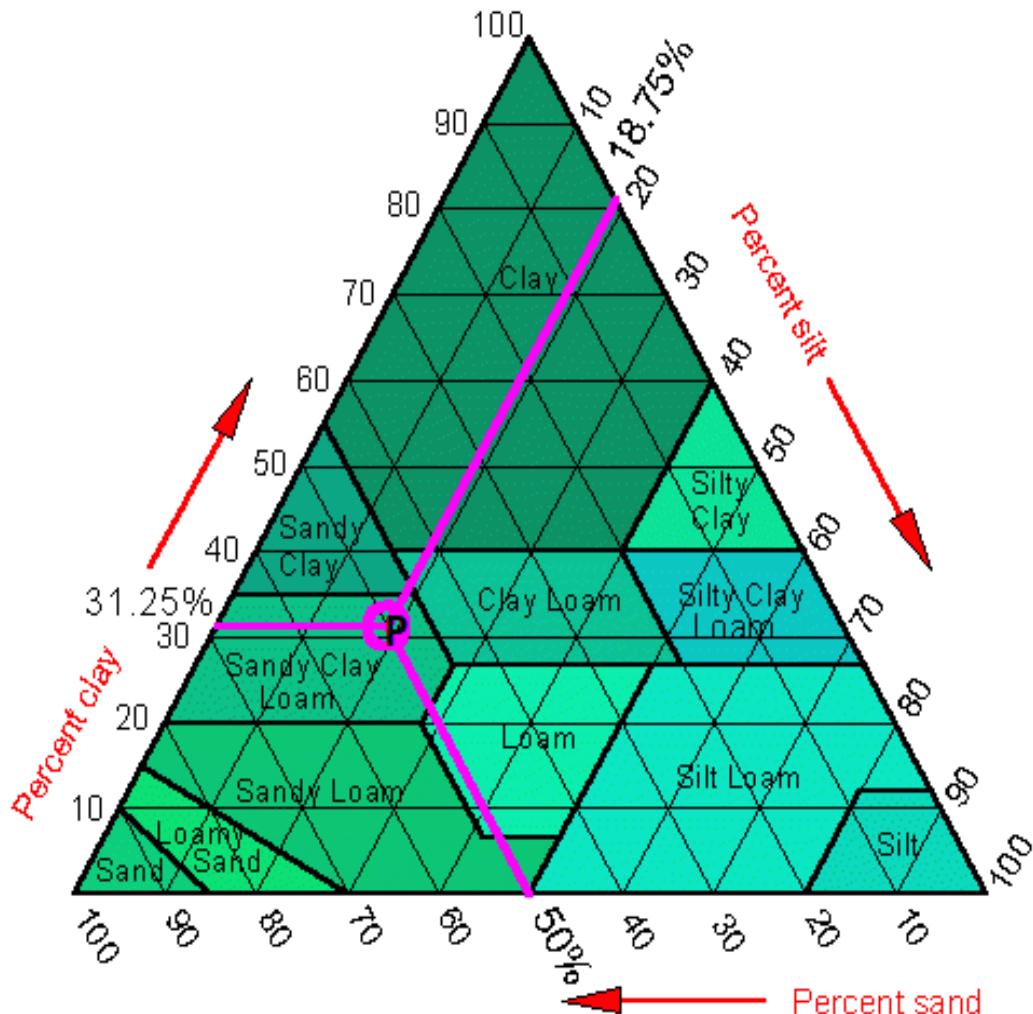


The twelve classified textures based on the percent of sand, silt, and clay --- shown in the above include

- |                    |                    |                 |
|--------------------|--------------------|-----------------|
| 1. Clay            | 5. Silt            | 9. Sandy loam   |
| 2. Silty clay      | 6. Clay loam       | 10. Loamy sandy |
| 3. Silty clay loam | 7. Loam            | 11. Sand        |
| 4. Silt loam       | 8. Sandy Clay loam | 12. Sandy clay  |

**Example**

- In the figure below P is located corresponding to 31.25% sand, 50% clay and 18.75% silt. Now the point will fall on the same zone clay. Hence the soil is classified as clay. To find the soil shown by P, move down to the left from sand at the bottom, horizontally to the right from clay at the left side of the triangle, down and to the left from the silt on the right side of the triangle

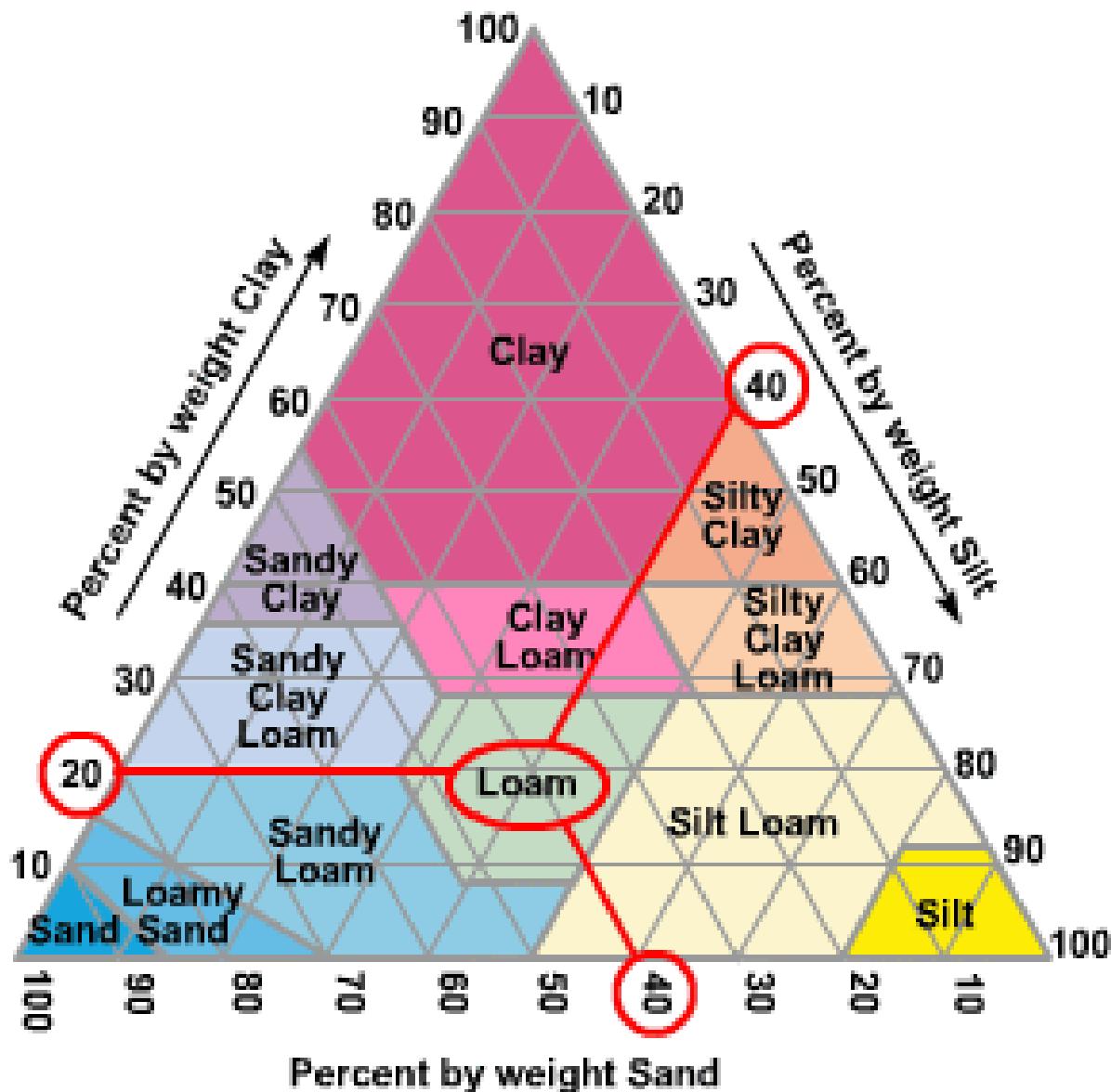


We will find that the soil is Sandy Clay Loam

**Example**

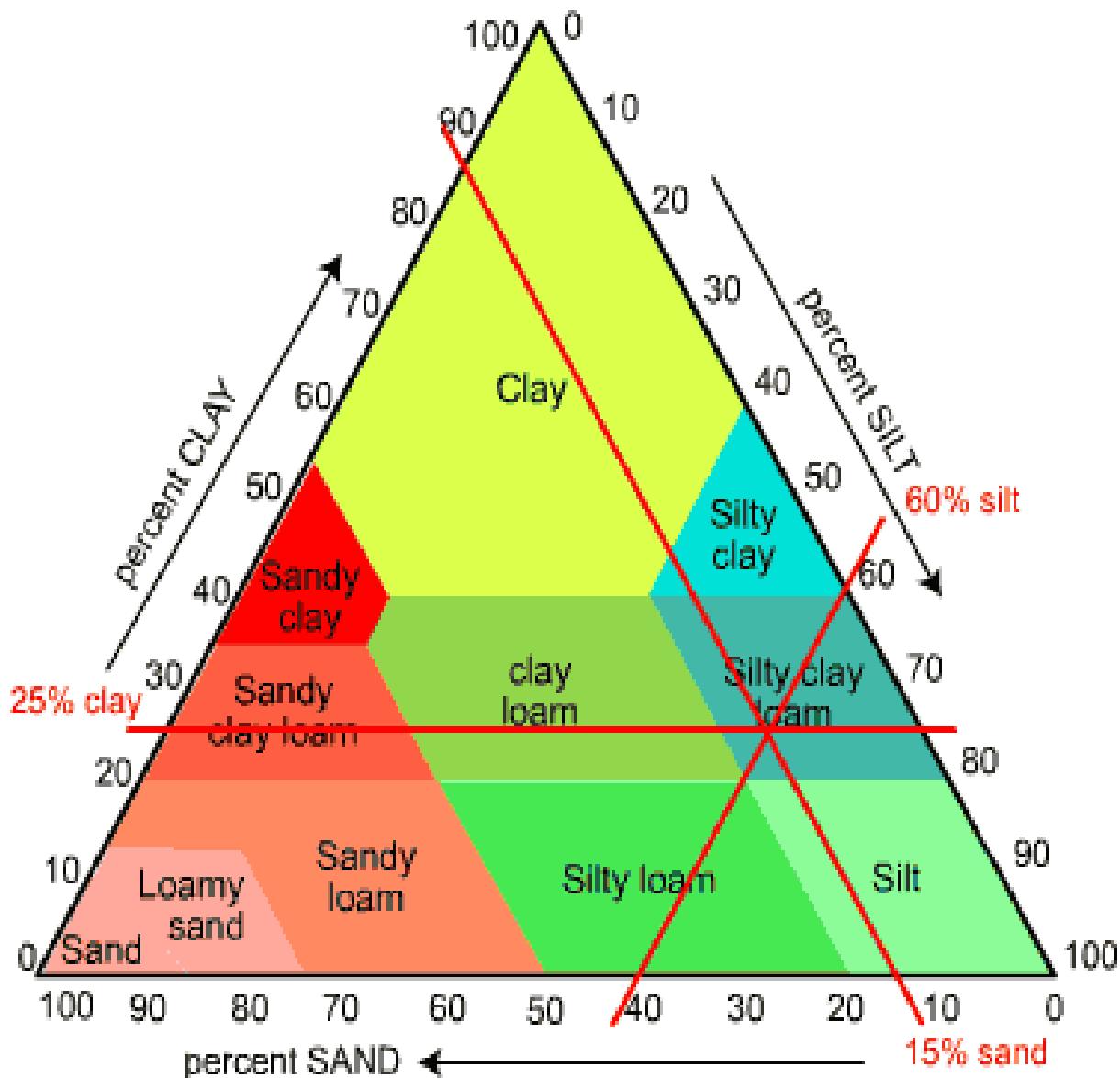
Form three Students of 2018 class at Target Secondary School found that the soil composed of 40% silt, 40% sand and 20% clay. Use the soil textural triangle, determine what the soil was. **See below how to find it.**

If we follow the lines on the chart up and to the left from sand at the bottom, horizontally to the right from clay at the left side of the triangle, down and to the left from the silt on the right side of the triangle, we will find that our soil is a **Loam soil**.



### EXAMPLE ONE

The students at Target Private Secondary School in Mzuzu City found that the soil composed of 60% silt, 15% sand and 25% clay. Use the soil triangle to find what this soil was? **See below how to find it.**

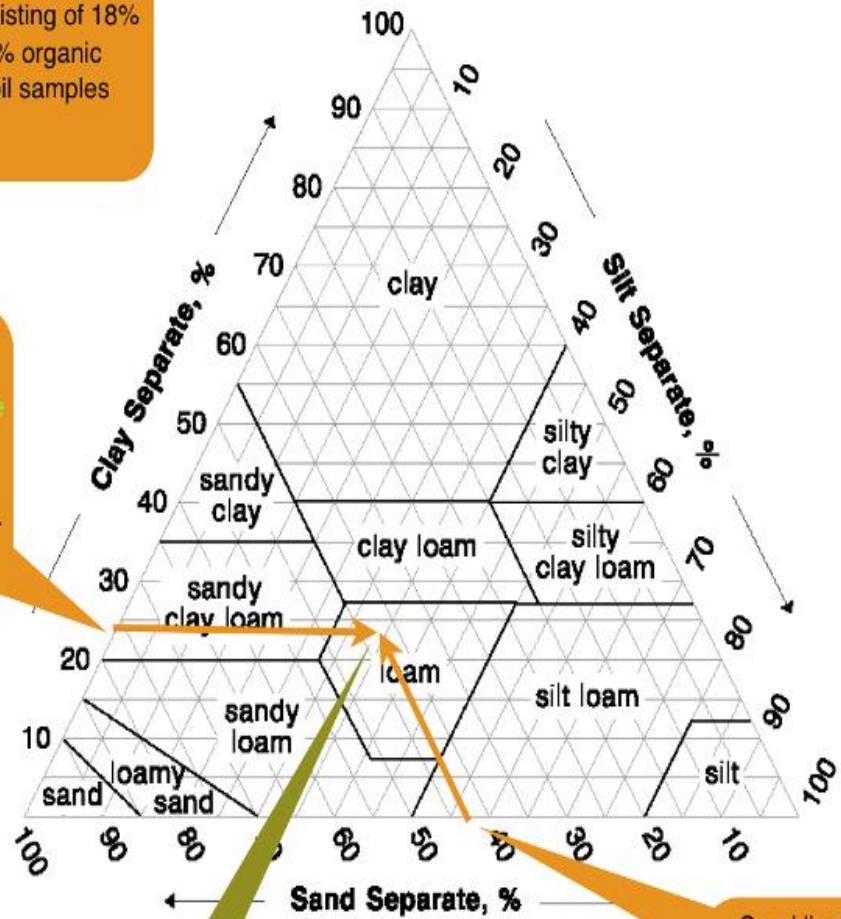


If we follow the lines on the chart up and to the left from sand at the bottom, horizontally to the right from clay at the left side of the triangle, down and to the left from the silt on the right side of the triangle, we will find that our soil is a **Silty clay loam**.

### EXAMPLE

A soil was determined to have a fine earth fraction consisting of 18% clay, 43% sand, and 2% organic matter. What is this soil sample's textural class?

Start with clay it's the most important! 18% clay start here (the clay line is horizontal) and look for where it intersects the sand line.



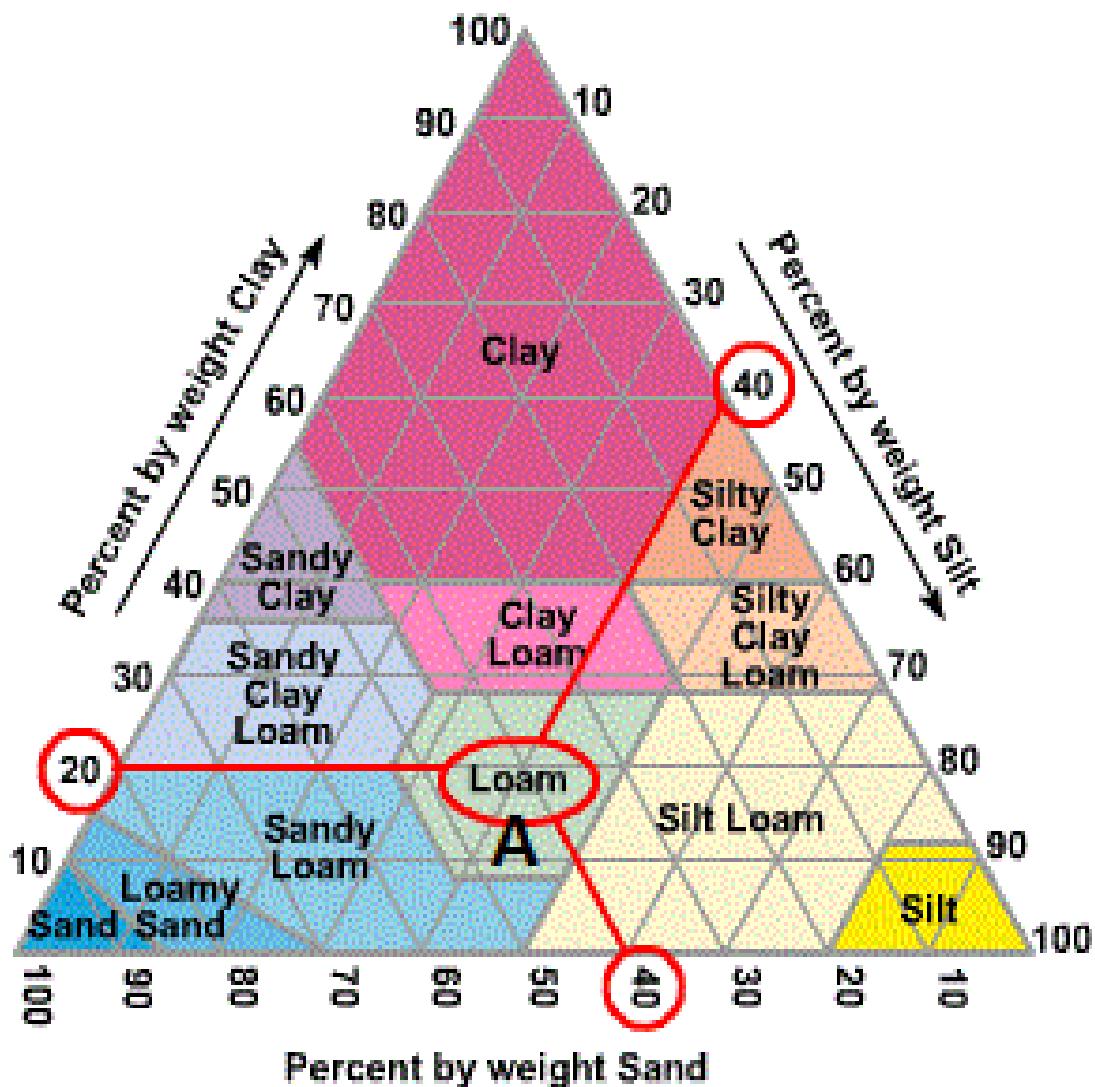
Sand lines are up and to the left and you were given 43%

### Example two

The jar is 40% silt, 30% sand and 30% clay. You can start at the 30% sand mark at the bottom of the triangle, following the diagonal line up and to the left until it crosses with the horizontal line for 30% clay coming in from the left side of the triangle. This will also be the point where the 40% silt line crosses, coming in from the upper right. This point on the triangle falls within the clay loam polygon. Therefore, our soil is a clay loam.

### EXAMPLE

The diagram shows how to determine soil texture based on the approximate percentage of soil size grades of a soil sample. For example, if a soil sample has about 40% silt, 40% sand and 20% clay, its texture is called loam point A in the triangle. From the silt, you follow the line up left; from the clay side, you follow the line straight line, and from the sand, you follow the line up. Where the three lines intersect, the soil is called loam.



### **QUESTION FOR REVIEW**

Use the soil texture triangle to name the following by its correct texture class

- a. 17 sand, 28 silt , 55 clay
- b. 31 sand, 55 silt, 14 clay
- c. 60 sand, 35 silt, 5 clay
- d. 5 sand, 57 silt, 38 clay

Determine the percentage of each particle size grade for the B example plotted on the triangle.

- a.** Sand: %
- b.** Silt: %
- c.** Clay: %

Determine the percentage of each particle size grade for the C example plotted on the triangle.

- a.** Sand
- b.** Silt
- c.** Clay

### **WAYS OF DETERMINING SOIL TEXTURE**

The methods which are used to determine soil texture include the following

#### **1. Sieve or sifting method**

The sieve method is used for the separation of the skeleton fractions (stones and gravel) from the earth fractions (sand, silt, and clay) of the soil and for the determination of the coarser earth fractions.

#### **Materials required**

- Soil sample
- Sieves of different sized mesh i.e. 2mm, 0, 2mm, 0.02mm, and 0.002mm in diameter.

#### **Procedures**

- Weigh the collected sample and record its mass
- Break the soil sample into small particles

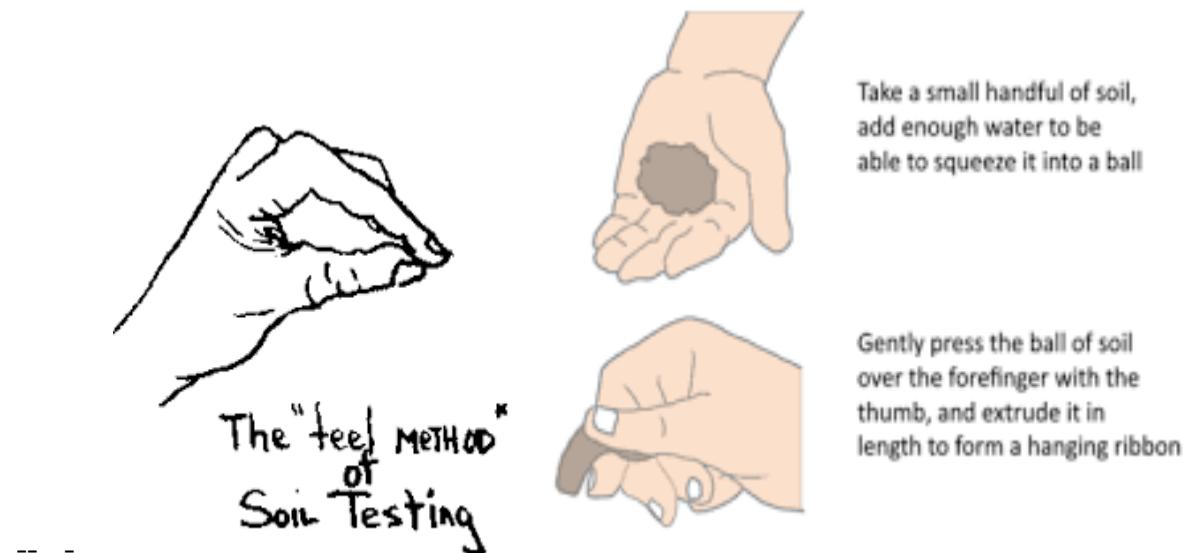
- Take a sieve of 2mm mesh. Sieves the soil through the 2mm mesh. Soil particles greater than 2mm in diameter will not pass through.



- Repeat the exercise with sieves of 0.2mm, 0.02mm, and 0.002mm.
- Weigh the samples in different sieves
- Calculate the percentage of each collected sample using the total weight.

## **2. Feel method**

Feel method involves taking a small sample of soil and making a ribbon. A ribbon can be made by taking a ball of soil and pushing the soil between the thumb and forefinger and squeezing it upward into a ribbon. Allow the ribbon to emerge and extend over the forefinger, breaking from its own weight.



### **Procedures that are followed under feel method**

Under this method

- Collect different lamps of soil
- add a little water to the soil
- Take- the soil between the thumb and the fore finger
- Feel the soil as you move the two fingers
- Try to mould the soil
- Sandy soils feels gritty and coarse while clay soil particles feel fine and sticky when wet. Clay can also be moulded into balls or sausages.

### **THE RESULTS FOR FEEL TEST**

**Feel test** – Rub some moist soil between fingers

- Sand feels gritty
- Silt feels smooth
- Clays feel sticky

**Ball squeeze test** – Squeeze a moistened ball of soil in the hand

- Coarse textures (sand or sandy loam) soils break with slight pressure
- Sandy loams and silt loams stay together but change shape easily
- Fine- textured (clayey or clayey loam) soils resist breaking

**Ribbon test** – Squeeze a moistened ball of soil out between thumb and fingers

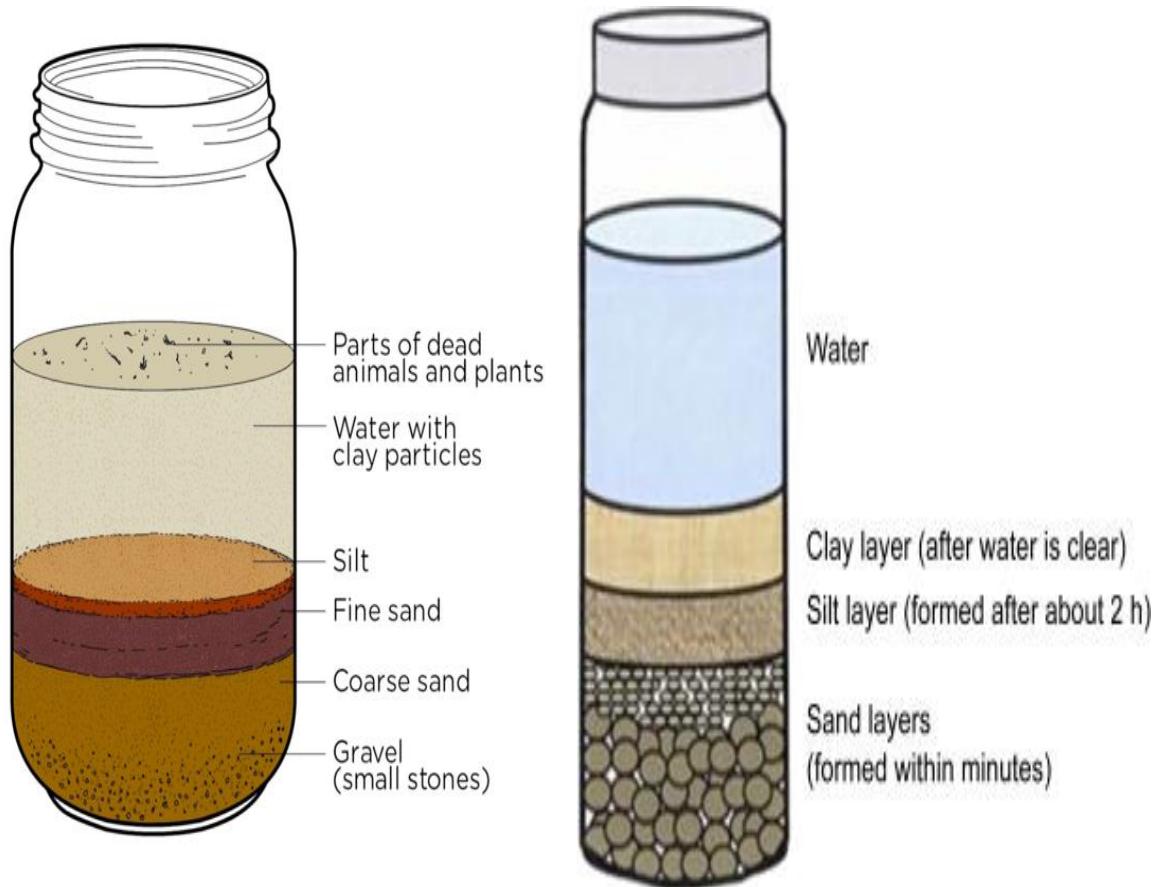
- Sandy or sandy soils won't ribbon
- Loam, silt, silty clay loam or clay loam soil ribbons less than 1 inch
- Sandy clay loam, silty clay loam or clay loam ribbons 1 to 2 inches
- Sandy clay, silty clay, or clay soil ribbons more than 2 inches

### **3. Sedimentation method**

Under this method

- Collect a dry lamp of soil
- Put soil sample into a transparent container or cylinder
- Add water until the cylinder is 75% full
- Shake vigorously

- Leave the cylinder to allow the contents to settle down.
- Soil settles according to their mass. The heaviest will settle first followed by the second -heaviest and so on.



- Determine the percentage of each particle found in the soil using the volume of each observed layer.

### **WHAT ARE THE EFFECTS OF SOIL TEXTURE ON CROP PRODUCTION?**

**The following are the effects of soil texture on crop production**

**1. It influences soil aeration**

Sandy soil allows air to circulate easily for root respirations and plant growth.

**2. It influences water holding capacity**

Clay soil holds more water than sandy soil for plant growth.

**3. It influences nutrients holding capacity**

Nutrients reach leach more easily in a course textured soil than in fine-textured soil but are more held more firmly for crop production in fine textured soil.

**4. It influences soil drainage**

Coarse textured soil is better drained for crop production than fine textured soil

**5. It influences tillage**

Coarse textured soils are easier to till than which is fine-textured.

**6. It influences resistance to erosion**

Sandy soil is easily eroded than clay soil.

**7. It affects the root development and extension.**

A soil which is too hard and compacted prevents roots from extending to search for water and mineral salts from wide volume of soil

**8. It influences the type of crop to grow.**

**WATER DRAINAGE AND RETENTION FOR DIFFERENT SOILS**

- Sandy soils are highly drained and have the lowest water holding capacity
- Loam soils are moderately drained and have moderate water retention
- Clay soils retain a high amount of water and poorly drained.

**CAPILLARITY IN SOILS**

- The water level will rise very fast in the capillary tube with sandy soil and later it will stop.
- In the capillary tube with clay, the water will rise very slowly.
- The water level for clay will be the highest followed by that of loam. Sand will have the lowest water level.

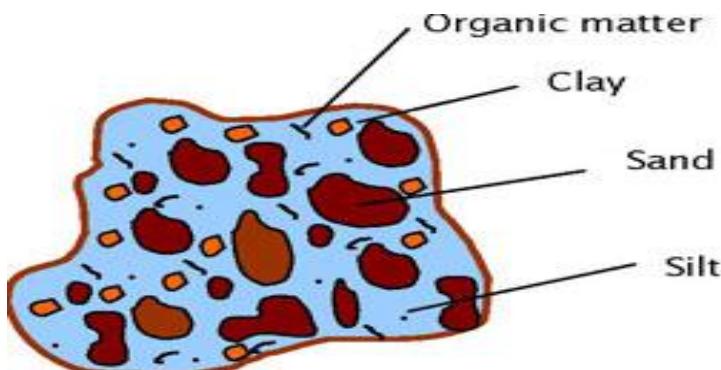
**CONCLUSION ON CAPILLARITY IN SOILS**

- Clay soils have the highest capillarity because of their finely closely packed soils
- Loam soils have moderately capillarity because they have a good proportion of sand, silt and clay. This provides them with medium sized pore spaces to allow reasonable amount of water to rise up in their pore space.
- Sandy soils have low capillarity because their loosely packed particles do not allow much upward movement of water.

**SOIL STRUCTURE**

Soil structure is defined as the arrangement of soil particles such as clay, sand and silt to form aggregate or collections.

Soil structure can also be defined as the arrangement of soil particle (sand, silt, clay and organic matter) into granules, crumbs or blocks.



The two cementing agents that make aggregation of soil particles are clay and organic matter (humus).

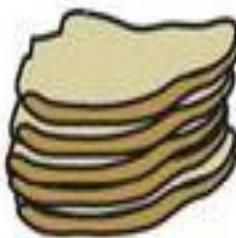
Soil structure is dictated by two things which include shape of soil particles and the arrangement of soil particles.

### **WHAT ARE THE TYPES OF SOIL STRUCTURE?**

The eight types of soil structure include

#### **1. Platy/massive structure**

This is the soil structure where particles are horizontally arranged on a plane. They are flat and plate-like. Soils with such structure have low permeability.

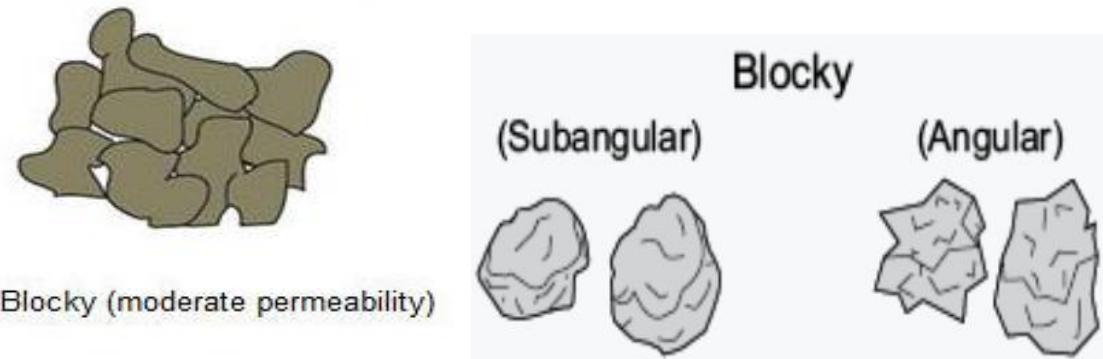


Platey (low permeability)



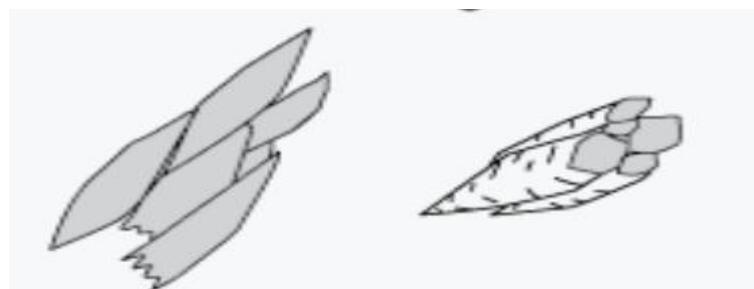
## **2. Blocky structure**

This is soil structure where particles are joined to form six-sided rectangular lumps (irregular blocks).



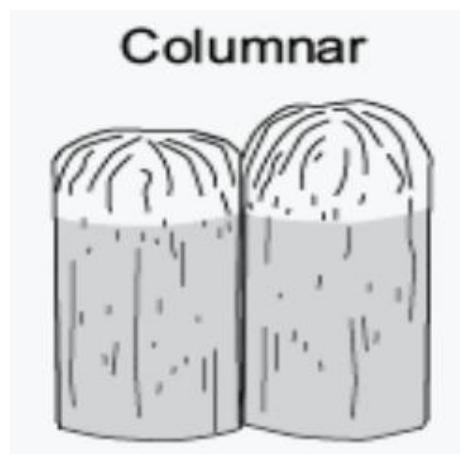
## **3. Cuboidal structure**

This is the soil structure where soil particles re-joined to form cubes or cube-like shapes.



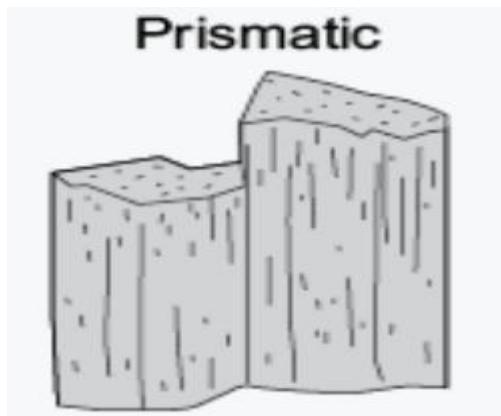
## **4. Columnar structure**

This is the soil structure where the soil particles are arranged in column with round- tops and cylindrical body.



### **5. Prismatic structure**

This is the soil structure where the soil particles join to form vertical pillars with flat tops.



### **6. Crumb structure**

This is the soil structure where the soil particles are loosely joined to form friable, porous aggregates with irregular shapes. This is the best soil structure that is suitable for arable crop production as it ensures a suitable balance between soil aeration and water holding capacity.



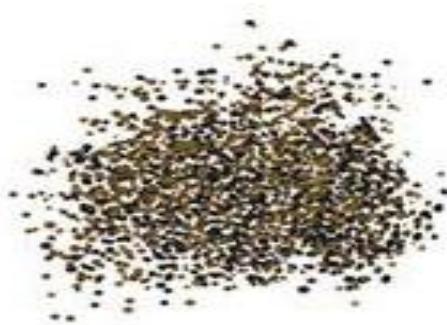
### **7. Single grained structure**

This is the soil structure where soil particles are not cemented together. Each soil particle is on its own e.g. sandy soil.

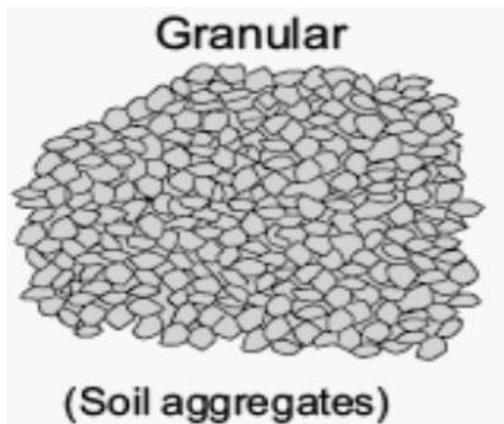


## **8. Granular structure**

This is the soil structure where soil particles are loosely packed, forming aggregates that are round or ovoid.



**Granular (high permeability)**



**(Soil aggregates)**

## **WHAT ARE THE EFFECTS OF SOIL STRUCTURE ON CROP PRODUCTION?**

The following are the effects of soil structure on crop production

### **1. Air circulation in the soil**

Single grained soil structures allow better movement of soil air for plant root respiration than platy soil structures.

### **2. Water holding capacity of the soil**

Crumb soils hold water for plants to use while single-grain and granular structures lose water more readily through seepage.

### **3. Microbial activities in the soil**

Crumb soil structures have a better environment for microorganism to live and work more actively to break down organic matter to release nutrients for plant growth than single grain structures.

### **4. Soil cultivability**

Granular structures are more workable than platy structures.

### **5. Nutrient retention**

Crumb structures reduce the rate of leaching of mineral salts while single grain structures lose nutrients through leaching more easily.

### **6. Root penetration and development**

Platy structures hinder root development while single grain structures facilitate root development.

### **WHAT ARE THE WAYS IN WHICH SOIL STRUCTURE CAN BE DESTROYED?**

The soil structure can be destroyed in the following ways

#### **1. Cultivating it when too wet or too dry.**

When- cultivation when it is too dry, it tends to break so easily. When it is too wet, the soil gets compacted during cultivation.

#### **2. Over cultivation**

Over cultivation leads to failure of the soil to recover after being broken

#### **3. Use of heavy machinery**

The use of heavy machinery leads to compaction of the soil and also breaks down the soil structure.

#### **4. Raindrops impact**

Heavy raindrops break the soil particles and fill up soil pores making it more difficult for water and air to enter the soil than before.

#### **5. Overgrazing**

Overgrazing leaves bare land thereby making it prone to raindrop impacts which break down the soil structure.

#### **6. Application of unsuitable chemical fertilizers**

The application of sodium compounds to the soil causes deflocculating or breaking down of soil structure.

### **WAYS OF IMPROVING/MAINTAINING SOIL STRUCTURE**

The soil structure can be improved/maintained by carrying out the following operations

#### **1. Planting vegetative cover on the bear land**

This will help to protect the bear land against the impacts of raindrops.

#### **2. Having correct crop population**

This can be achieved by planting the correct number of plants in field which ensures complete coverage of land against raindrop impact.

**3. Using organic fertilizer/manure**

This will help to bind the soil particles together and also ensures stability of aggregates.

**4. Crop rotation**

This will --help the land to rebuild itself.

**5. Use of fallowing/zero tillage**

This involves leaving the arable crop land free for some years which enables the land to- regain its organic matter which cements soil particles together to form aggregates.

**6. Proper use of heavy machinery**

This involves combining the operations such as ploughing, harrowing and ridge construction which helps to reduce soil compaction.

**7. Avoiding overgrazing**

This helps the soil not to be compacted and does not lose vegetative cover.

**SOIL COLOUR**

Soil colour is defined as the appearance of the soil.

**WHAT ARE THE FACTORS THAT AFFECT SOIL COLOUR?**

**1. Parent material**

Reddish/brown soils indicate that they contain iron, silica or quartz (limestone) which are whitish in colour and mica has glittering/shiny appearance.

**2. Organic matter**

Soils that contain large quantities of organic matter are usually dark/black in - colour. See the humus/organic matter in the soil profile below.

**3. Drainage and aeration**

The poorly drained and aerated soils are usually grayish as opposed to well drain-ed soils which are brownish in colour.

**WHAT ARE THE EFFECTS OF SOIL COLOUR ON CROP PRODUCTION?**

The following are the effects of soil colour on crop production:

1. It keeps soil temperature warm like black colou

2. It influences the rate at which mineral salts dissolve in soil water and become available for plant's use.
3. It influences the rate at which enzymes in the seeds can break down food reserves necessary for seed germination.
4. It influences the activities of micro-organisms which decompose organic matter.

### **SOIL CONSISTENCY**

Soil consistency is the state of soil under different conditions.

For example, clay soil when dry tend to be very difficult to break and sticky when wet. This implies that it is difficult to work with when it is dry or wet.

Some soils like loam and sand are soft and break easily with slight pressure.

### **EFFECTS -OF SOIL OF SOIL CONSISTENCY ON CROP PRODUCTION**

The following are the effects of soil consistency on crop production

#### **1. Workability**

Sticky soils are difficult for the farmer to work with because the soil sticks to farming implements like hoe, ploughs, ridgers etc

#### **2. Destruction of soil structure**

Plastic/sticky soils get compacted and reduce their porosity. This in turn reduces air circulation, water infiltration and percolation and plant root penetration through the soil.

#### **3. Erosion**

Soils that are weakly cemented easily break into individuals' soil grains and become more subjects to erosion.

#### **4. Seedling emergence**

Plastic soils break easily by heavy rainfall. This makes it difficult for emerging seedlings to get out of the soil.

### **SOIL POROSITY**

- Soil porosity is defined as the percentage volume of the total bulk of the soil which- is not occupied by soil particles.

- Soil porosity can also be defined as the proportion of volume of soil that is taken up by pore spaces.
- **Clay soil** has the highest porosity because it has tiny pores which are many.
- Sandy soils have the lowest porosity because it has few pore spaces which are large in size.

### HOW TO DETERMINE SOIL POROSITY

- Soil porosity is best determined by bulk density and particle density.
- Bulk density refers to the mass of oven dry soil divided by volume of oven dry soil which includes both pore spaces and solid particles.
- Particle -density refers to the mass of unit volume of solid soil.

$$\text{Particle density} = \frac{\text{Weight of soil soil}}{\text{Volume of the solid soil}}$$

- Bulk density is found by dividing weight of oven dry soil by volume of oven dry soil.

$$\text{Bulk density} = \frac{\text{Weight of oven dry soil}}{\text{Volume of oven dry soil}}$$

- Particle density is found by dividing weight of solid soil by volume of the soil.
- There % porosity =  $\frac{\text{bulk density}}{\text{particle density}} \times 100$

### HOW DOES SOIL POROSITY AFFECT CROP PRODUCTION?

#### 1. Aeration

This supplies oxygen for seed germination, root respiration and microbial activities like decomposition of organic matter.

#### 2. Water infiltration and percolation

Soil dominated by micropores such as clay soil restrict water infiltration and encourages water runoff while sandy soil though it has low porosity water movement is surprisingly high due to presence of macropores.

#### 3. Nutrient retention

Porous soils are poor in retaining nutrients because most of them are drained to deeper soil horizons where most plants cannot reach.

**4. Root penetration and development**

Micropores impede root penetration thereby reducing yield in crops like cassava and potatoes.

**SOIL TEMPERATURE**

Soil temperature is defined as the coldness or hotness of the soil.

**HOW IS THE SOIL TEMPERATURE DETERMINED**

Soil temperature is determined by thermometer. The thermometer is pushed into the soil and waits to see by consistent readings for few days.

**WHAT ARE THE FACTORS THAT AFFECT SOIL TEMPERATURE?**

The following factors affect soil temperature

**1. Soil colour**

Dark soils tend to absorb more heat from the sun than soils which are light in colour.

**2. Vegetative cover**

Soil covered by vegetation receive less heat from the sun than soil which is open ground-

**3. Soil moisture content**

A moist soil is generally cooler than dry soil

**4. Latitudes**

Soils that are close to the equator are hotter than those soils close to the poles and this is because the sun is overhead more times than any other place on the earth.

**5. Season of the year**

The soil is hotter which is exposed to sunlight longer in summer than in winter

**6. Slope of the land**

A garden which slopes towards the north in the Southern Hemisphere is heated more than land which faces south.

**7. Soil depth**

Soil temperature varies quite a lot with below the surface. However top soil experiences more temperature variation or fluctuations than sub soil.

### **WHAT ARE THE EFFECTS OF SOIL TEMPERATURE ON CROP PRODUCTION?**

The following are the effects of soil temperature on crop production

#### **1. Water evaporation**

This depends on soil temperature and becomes critical when rains become inadequate/erratic.

#### **2. Chemical reactions in the soil**

It makes mineral salts to dissolve in soluble materials and become available to plants.

#### **3. Chemical weathering rates**

Low temperatures reduce chemical breakdown and synthesis of chemical compounds- found in the soil that make nutrients available for plants' use.

#### **4. Biological activities**

Decomposition of organic matter and nitrification do not start until temperature is around 20°C. The most favourable limit is between 38°C and 42°C.

#### **5. Seed germination**

Seed germination speeds when the soil is warm and slow down when it is cold.

#### **6. Root growth-**

Plant roots grow best at 25°C. They are prone to injury at high temperatures.

#### **7. Absorption and transport of water and nutrients**

Low temperature greatly affects absorption of water and nutrients in higher plants.

#### **8. Transpiration and evaporation**

The higher the temperature, the greater the evaporation, transpiration and evapotranspiration

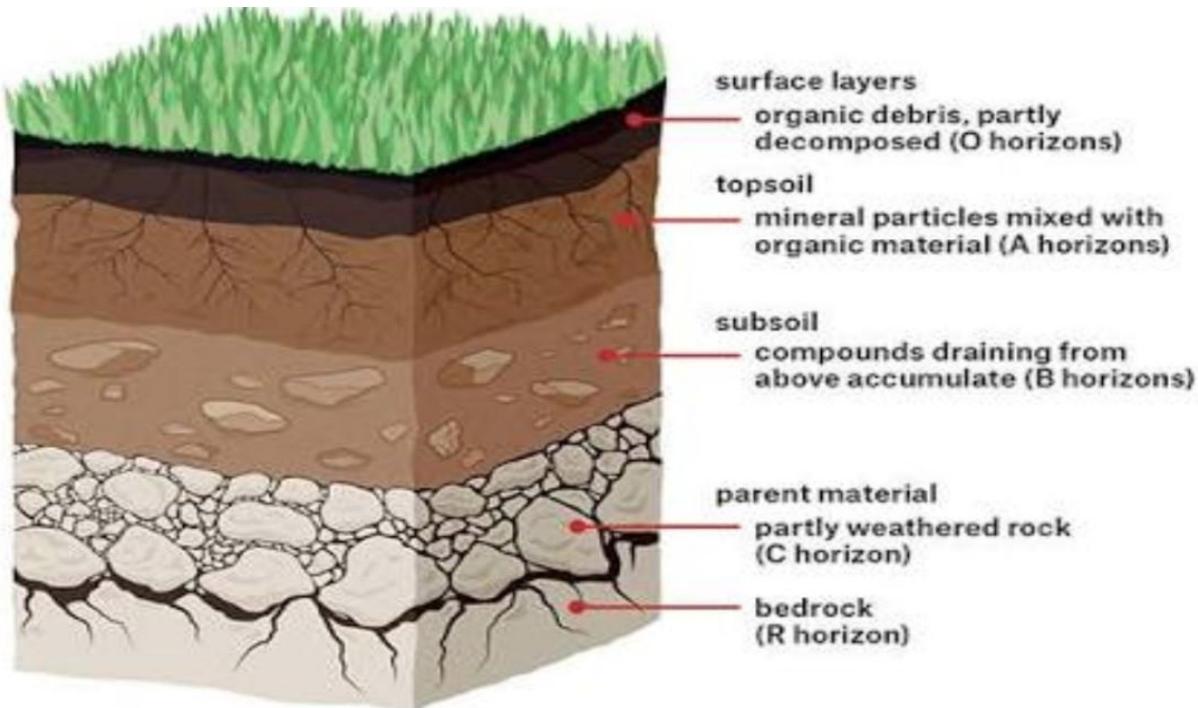
### **SOIL DEPTH**

Soil depth refers to the combined depth of the soil and sub soils

Examples of deep rooted crops which need deep soils in order to do well include

- a. Cotton
- b. Tea-
- c. Coffee

Soils which are well developed and mature tend to be deep. Deep soils have a very deep top soil layer. They also have a well -developed sub soil layer. See the diagram below.-



### **FACTORS THAT AFFECT SOIL DEPTH**

The factors include

#### **1. Slope of the land**

Soils on steep slope are shallow because of erosion while on flat and low lands are deeper because there is no relatively erosion and some soils are deposited there from highlands.

#### **2. Parent material**

Parent materials that are resistant to erosion take long time to form than those which are less resistant. More and deeper soils are therefore formed making them deeper.

### **WHAT ARE THE EFFECTS OF SOIL DEPTH ON CROP PRODUCTION?**

**1. It affects the amount of nutrients the soil can hold**

The deeper the soil, the larger the volume of plants can exploit in search for - nutrients.

**2. It determines the choice of that can be grown on particular land**

Soils that are deep and loose are favourable for most plants because their roots can go as deep as they want without restriction. On the other hand, shallow soils can only accommodate shallow rooted crops.

**3. It influences the amount of water a soil can hold for plant use**

The deeper the soil, the more the water it can hold, making it possible for crops to survive longer periods of spell/droughts.

**4. It helps in controlling soil erosion**

Deep soils hold large volume of rain water,. This in turn reduces possible incidents of soil erosion by running water which occurs because the soil cannot hold any more rain water.

**5. Soil aeration**

The deeper the soil, the greater the aeration in the soil for root respiration and development for increased crop production.

**6. Microbial activity**

The deeper the soil, the greater the zone available for soil micro-organisms to break down organic matter to release nutrients for plants.

**CHAPTER TWO: CHEMICAL PROPERTIES OF THE SOIL**

The chemical properties of the soil that affect the availability of essential mineral elements in the soil and activities of micro-organisms include

**1. Soil pH**

Soil pH refers to the degree of acidity and alkalinity of a soil. This is the result of concentration of hydrogen ions ( $H^+$ ) and hydroxyl ion ( $OH^-$ ).

**WAYS OF DETERMINING SOIL PH****a. USE OF UNIVERSAL INDICATOR****Materials required**

- Dry soil sample
- Distilled water
- Test tube
- Cork
- Barium sulphate
- Universal indicator
- pH scale

#### **PROCEDURE TO BE FOLLOWED**

- Take a small sample and grind it
- Put it in a test tube
- Add a chemical like barium sulphate to break the soil particles further.
- Add distilled water in a test tube followed by few drops of universal indicator.
- Cover the top with a cork.
- Shake the test tube vigorously
- Let the mixture settle for not less than 30 minutes
- Observe the colour change in the test tube
- Compare the colour change in the test tube with the colour on the chart and read off the pH.

#### **RESULTS EXPECTED**

- a. If the soil is acidic the indicator changes to red.
  - b. If the soil is an alkaline it changes to blue.
  - c. If the soil is neutral it changes to green
- pH less than 7 indicates the soil acidic.
  - pH greater than 7 indicates a basic/alkaline soil.
  - pH 7 indicates a neutral soil.

#### **b. DETERMINING SOIL PH USING LITMUS PAPER**

Materials require:

- Soil sample
- Distilled water

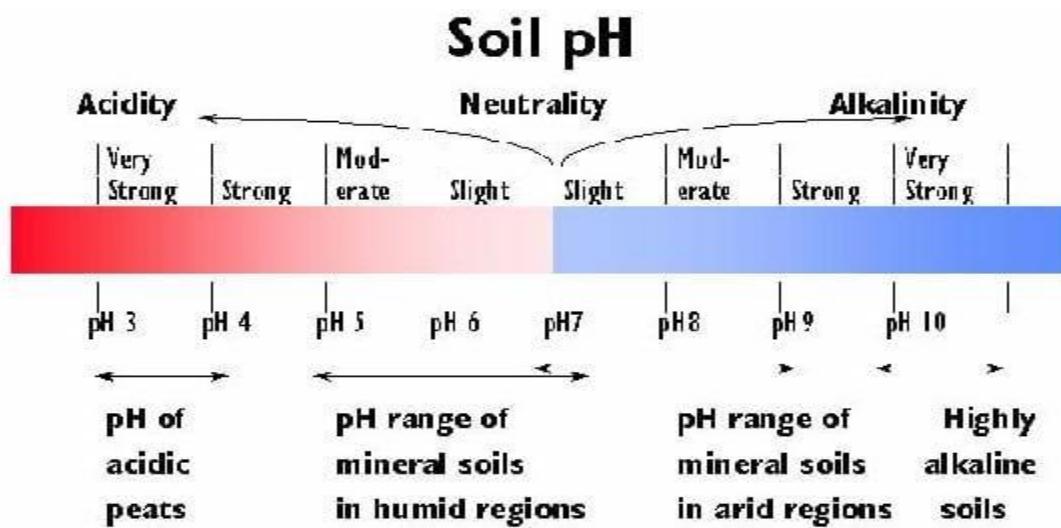
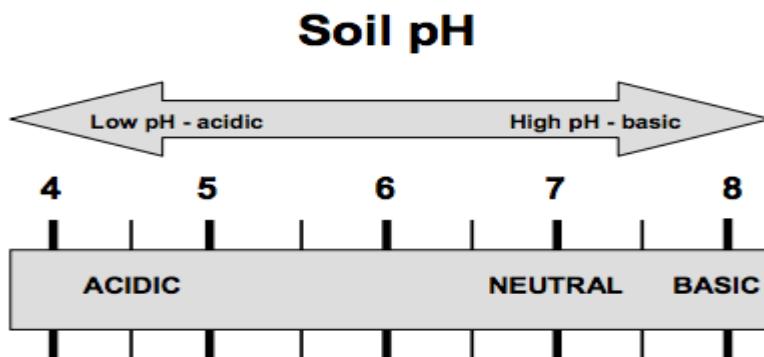
- Test tube
  - Litmus paper (both blue and red)
  - pH scale

## **PROCEDURE**

- Put a well grinded soil into a test tube
  - Add distilled water
  - Add -barium sulphate to break soil particles to individual grains
  - Let the mixture settle down
  - Dip -litmus paper
  - See the colour cane on the litmus paper

## **EXPECTED RESULTS**

- Red litmus paper turns blue if soil is basic and
  - Blue litmus paper turns red if the soil is acidic.



### **WHAT ARE THE FACTORS THAT AFFECT SOIL PH?**

The following are the factors that affect soil pH:

#### **a. Use of acid forming fertilizer**

The continuous and heavy application of sulphate of ammonia makes the soil acidic.

#### **b. Leaching**

When the plant nutrients such as calcium ions, magnesium ions and sodium ions are reached down the soil profile, they are replaced by hydrogen ions which lower soil pH

#### **c. Microbial activity**

Reduces soil pH as hydrogen ions are released during decomposition of organic matter making the soil acidic. Carbon dioxide produced by microbes dissolves in water to form carbonic acid decreasing soil pH (making soil acidic)

#### **d. Acid rains**

Carbon compounds emitted into the atmosphere in industries when combines with water to form from carbonic acid which gets incorporated into the soil making it acidic.

#### **e. Crop removal**

Crops absorb various ions in the soil and after harvesting if the crops are not incorporated into the soil, this will leave hydrogen ions to dominate the soil making the soil acidic.

#### **f. Weathering of parent material**

If the parent material contains sulphur, PH is reduced through the formation of sulphuric acid, making soil acidic.

Soils from limestone have a high PH making them alkaline.

Parent material also results in accumulation of ions like potassium ions, sodium and magnesium ions which increase soil PH making it alkaline.

#### **g. Drainage**

It is linked to leaching and sandy soil since it is highly leached which tend to have low PH than clay soil which has high soil PH due to low levels of leaching.

#### **h. Type of vegetation**

In the forest, soil PH tends to be low as compared to grassland. This is attributed by high levels of soil decomposition of organic matter.

### **WHAT ARE THE WAYS OF MODIFYING SOIL PH?**

#### **Soil PH can be modified in the following ways**

- a. Application of agricultural lime which contains calcium oxide. The application of agricultural lime to the soil neutralizes soil acidic.
- b. Application of manure such as khola manure reduces soil acidity.
- c. Application of inorganic fertilizer like sulphate of ammonia decreases soil PH i.e. makes soil acidic.

### **WHAT ARE THE EFFECTS OF SOIL PH ON CROP PRODUCTION?**

These include

#### **a. Affects availability of soil nutrients**

For example, at low PH become insoluble by forming less soluble compound like iron and aluminum while iron and potassium become available in the soil at high soil PH and plants can access them.

#### **b. It determines the choice of crop to be grown in an area**

For example, acid soils are best for tea production.

#### **c. High acid soils limit the activities of micro organism.**

This means organic matter incorporated into the soil will not decompose and nutrients will not be released for plant growth.

- d. **In acidic soils**, damage of crops by nematodes is more serious than in neutral soils.

## **2. NUTRIENT STATUS OF THE SOIL**

This has to do with availability of different minerals in a soil in right proportions. It is these nutrients which determine a soil's capacity to support crops.

### **WHAT ARE THE FACTORS THAT AFFECT THE NUTRIENT STATUS OF THE SOIL?**

**These include**

**a. The parent material from which soil was formed.**

Soils formed from limestone tend to have high contents of calcium. While soils formed from sandstone and granites give rise to sand soil which is low in nutrient contents.

**b. Soil pH.**

- It affects availability of nutrients in the soil for instance phosphorous in acidic soils become insoluble and therefore unavailable to plants.
- It also influences multiplication and activities of beneficial soil organisms some of which are responsible for nitrogen fixation and decomposition of organic matter.

**c. Leaching**

Soluble salts like nitrates are easily washed down the soil profile in sandy soils during heavy rainfall, leaving the top soil with low nutrient status.

**d. Nutrients uptake by plants**

Nutrients extracted by crops if not ploughed back into the soil, more nutrients are lost.

**e. Crop removal**

Nutrients- are removed with crops as they are being harvested.

**f. Method of cultivation**

The use of bushfire to clear the land, overgrazing, monocropping, improper use of farm machinery, cultivation of marginal land affects the availability and removal of plant nutrients.

**WHAT ARE THE EFFECTS OF NUTRIENT STATUS ON CROP PRODUCTION?**

The following are the effects of nutrients status on crop production

**a. It affects vegetative growth of crops**

For example, nitrogen is responsible for synthesis of protein molecule which is necessary- for growth.

b. **Some nutrients such as phosphorous** brings forth resistance against diseases due to lignin they form

**c. They affect maturity of crops**

Tobacco matures if the amount of phosphorous supersedes that of nitrogen.

Nitrogen promotes succulence while phosphorous brings maturity.

**d. It affects yield potential of the crops**

Therefore it is important for the farmer to maintain high nutrient status of the soil by applying fertilizers.

**e. Soil PH**

This determines the choice and productivity of the crops.

**3. SALINITY**

- Salinity is defined as the condition of the soil that is associated with the accumulation of soluble salts in the soil.
- Saline soils are the soil that contains concentration of neutral soluble salts with a PH of more than 8.5.

**SALINE SOILS**

- **Saline soils** are sometimes called **White Alkaline Soils**. This is when a white layer on top of soil becomes very visible.

**Examples of soluble salts**

These include

- a. Nitrates
- b. Sulphates
- c. Chloride
- d. Bicarbonate

**SODIC SOILS**

- Sodic soils are soils which contain high amount of sodium.
- These soils tend to accumulate on the surface as white substances and tend to be licked by goats and cattle.

- These soils- are common in Chikwawa, Kasungu and Mzimba where people even make salts.

### **SALINE-SODIC SOILS**

- Saline-Sodic soils are soils which contain both soluble salts and sodium salt and are toxic to plants.

### **CAUSES OF SALINITY**

The following are the causes of salinity

- a. Irrigation virgin land with poor quality water which can be visibly be seen on the surface.
- b. Application of fertilizers which eventually lead to accumulation of soluble salts.
- c. Parent material which as it weathers, it releases its salts into the soil.
- d. Low rainfall and evaporation
- e. Poor drainage resulting in build -up of soils.

### **WHAT ARE THE EFFECTS OF SALINITY ON CROP PRODUCTION?**

The following are the effects of salinity on crop production

#### **a. It causes plasmolysis in plants**

Plasmolysis is the condition in which plants lose water from the cells to the soil in attempt to balance off salts concentration between plant and soil and causes death of the plant.

#### **b. It causes toxicity to plants**

Salinity causes the roots causing impairment in absorption of water and mineral salts

#### **c. Prevents drainage of excess water from farmable land**

This is caused by the increase of sodium in the soils since the sodium ions tend to disperse mineral colloids which then develop a tight, impervious soil structure.

#### **d. It affects microbial activities.**

Salinity interferes with microbial activities such as nitrification, decomposition of organic matter which is beneficial to crops sine saline soils are basic.

### **4. Cation exchange capacity**

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- Cation exchange capacity is defined as the ability of the soil to exchange cations.
- Cation exchange capacity can also be defined as the measure of ability to hold and release various nutrients for plant use
- **Examples of exchange cations (positively charged ions) include**
  - a. Calcium ions
  - b. Sodium ions
  - c. Magnesium ions
  - d. Potassium ions
- **Examples of anions (negatively charged ions) are**
  - a. Chloride -ions
  - b. Nitrate ions
  - c. Carbonate ions
- **Cations** are held or absorbed into colloids and organic matter while **anions** are found in soil solution.
- Cations are not easily leached in the soil because they are strongly attracted to clay organic- matter because they are positively charged. However can be replaced in the soil through cation exchange process.

#### **EXAMPLE OF CATION EXCHANGE PROCESS**

- When lime is added to acidic soils with high concentration of hydrogen ions. Calcium and magnesium in the soil will replace the hydrogen ions thereby raising the soil PH. This in turn improves soil condition.
- Organic matter is a warehouse for plant nutrients and is crucial for the formation of aggregates.
- Examples of plant nutrients which are found in the organic matter include
  - a. Calcium ions
  - b. Magnesium ions
  - c. Potassium ions
  - d. Sodium ions

- Sand has no capacity to exchange cations because it has no electric charge. This can be improved by adding organic matter.

**WHAT ARE THE EFFECTS OF CATION EXCHANGE CAPACITY ON CROP PRODUCTION**

The following are the effects of cation exchange capacity on crop production

- a. It enables nutrients that are strongly held/adsorbed by clay or organic matter to be released to the soil solution where they become available for plants use.
- b. It also enables cations to be transferred from soil solution and become adsorbed by clay and organic matter where they cannot easily be lost by leaching.
- c. It enables hydrogen held by colloids and humus be replaced by basic elements such as calcium and magnesium and in the process reduce soils acidity.
- d. It helps to improve or modify soil Ph
- e. It affects the total amount of nutrient cations present in the soil.

**NB:** Adsorption is defined as a process by which soil particles attract and hold some mineral- nutrients rightly, making them unavailable to plants.

**CHAPTER THREE: AGRICULTURAL DEVELOPMENT AGENCIES AND THEIR SERVICES**

The following are the agricultural development agencies found in Malawi with their associated roles that they play in agricultural production

<b>Agricultural Development Agency</b>	<b>Services provided in Malawi</b>
Department of Agricultural Research Services	Research
The Agricultural & Marketing Corporation	Marketing
Land Resources and Conservation Unit	Infrastructures
Agriculture Communication Branch	Extension
Marketing Agents	Processing
Department of Agricultural Research (DARS)	Production
The Financial Rural Finance Company	Credit

**SERIVCES OFFERED BY AGRICULTURAL DEVELOPMENT AGENCIES**

## **1. Research**

- Research is defined as an investigation that is carried out in order to find out the solution to a problem. It is designed to collect, analyze and interpret data into information which is useful.
- An Agricultural Development Agency in Malawi that conducts research is the **Department of Agricultural Research**. It does this in order to provide farmers with information which creates an increase to production and their commodities.

## **EXAMPLES OF AGRICULTURAL RESEARCH ACTIVITIES**

The following are the examples of agricultural research activities

- Testing soil samples to determine their fertility levels and to make recommendations on fertilizer application.
- Testing, certifying and monitoring the production, processing and storage and marketing seeds.
- Breeding and releasing resistant crop varieties.
- Establishing plant quarantines and other government control measures.
- Plant pest diagnostic and advisory services provided by the ADMARC.
- Recommending the use of specific pesticides supplied by ADMARC.
- Improving genetic makeup of livestock in order to improve production.
- Providing artificial insemination services for dairy farmers to achieve cross-breeding.
- Testing, certifying and monitoring the production and release of farm machinery.
- Analyzing, testing and making fertilizers recommendations.

## **IMPORTANCE/ROLES OF AGRICULTURAL RESEARCH SERVICES TO THE GROWING POPULATION**

- a. They provide high yielding varieties and livestock breeds.
- b. They enable farmers to obtain high quality from their crops and livestock in terms of nutritive value, flavor and colour.

- c. They help to increase farm income by increasing yields per unit area or per animal.
- d. They help to come up with superior inputs and technologies to make farming more profitable and reliable.
- e. They introduce new methods of crop and animal husbandry.
- f. They find out better ways of reducing the negative effects of climate change, pest, diseases, parasites in crop and livestock.
- g. They help to improve farming systems by finding out better and more efficient ways of mechanization, input use and risk management.
- h. They help to come up with better ways of reducing post-harvest loses in storage.

### **THE MAIN EXAMPLES OF AGRICULTURAL RESEARCH STATIONS FOUND IN MALAWI**

These include

#### **1. Lifuwu Research Station**

It is found in Salima for Groundnuts and Rice Research

#### **2. Chitala Research Station**

It is found in Salima for Groundnuts and Cotton Research

#### **3. Makoka Research Station**

It is found in Zomba for Cotton.

#### **4. Baka Research Station-**

It is found in Mzimba for Livestock research

#### **5. Bvumbwe Research Station**

It is found in Thyolo for Horticulture.

#### **6. Chitedze Research Station**

It is found in Lilongwe for Legumes and Farm Machinery

#### **7. Lunyangwa Research Station**

It is found in Mzuzu for Pastures and Livestock

#### **8. Mwimba Research Station**

It is found in KASUNGU for Tobacco Research

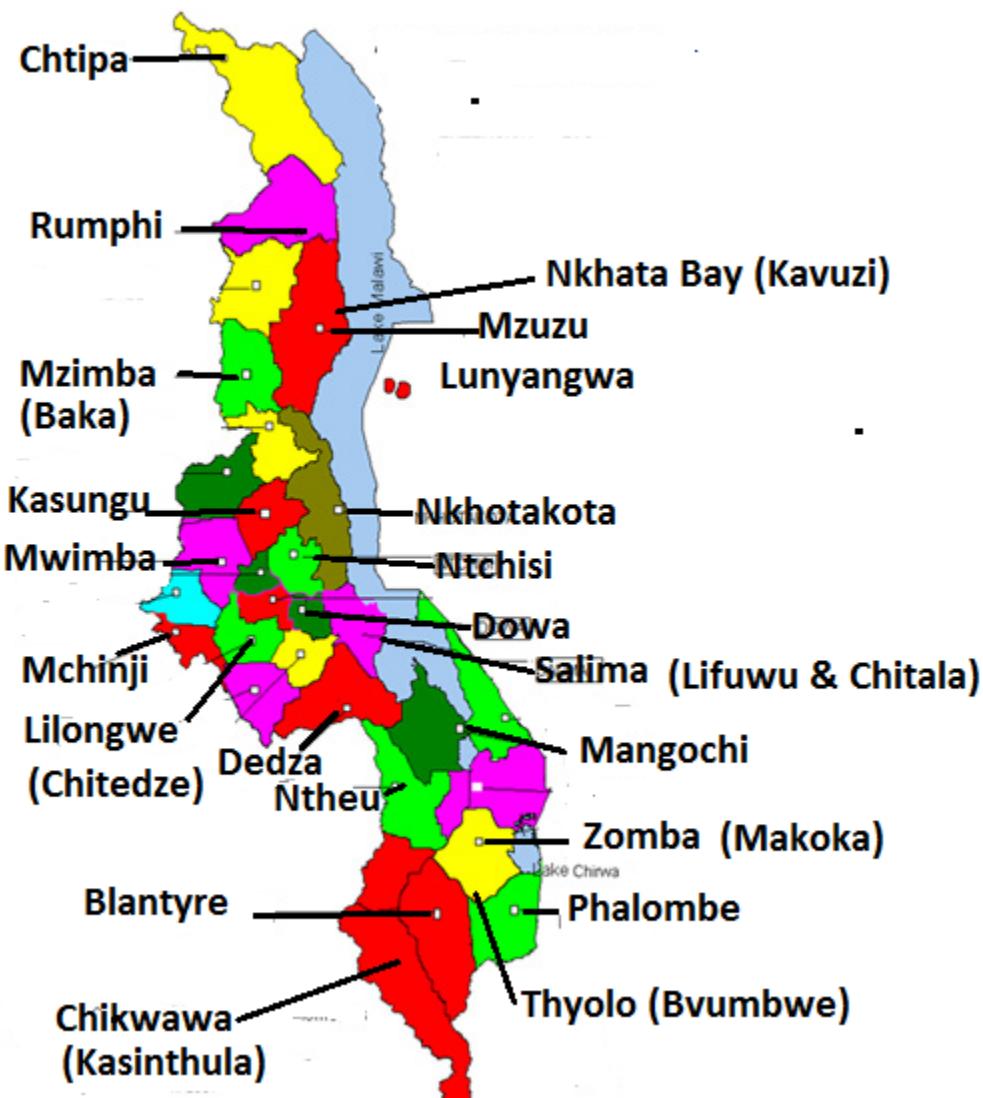
**9. Kasinthula Research Station**

10. It is found in Chikwawa for Rice Research.

**11. Kavuzi Research Station**

It is found in Nkhata Bay for Coffee Research

**MAP OF MALAWI SHOWING AGRICULTURAL RESEARCH STATIONS**



**2. Marketing**

- Marketing refers to the whole range of activities which are involved in the transfer of a commodity from point of production to the point of consumption.
- Marketing activities include buying, selling, grading of the products, transporting of the products/produce, storing the produce etc.

- ADMARC is mandated by Parliament in Malawi to carry out various marketing activities.
- The following are the roles played by ADMARC in Malawi
  - a. Planning, monitoring and regulating crop production
  - b. Licensing crop production for example tobacco.

### **IMPORTANCE OF AGRICULTURAL MARKETING SERVICES**

These include

- a. Provide farm inputs to the farmers.
- b. Providing an income to farmers after selling their produce
- c. Adding value to farm produce after grading
- d. Providing foreign currency after exporting the produce.
- e. Distributing goods and services through the transport function of marketing.
- f. Encouraging farmers to use wisely to produce more and better quality products.

### **3. AGRICULTURAL INFRASTRUCTURAL SERVICES**

Agricultural infrastructural service is defined as large scale basic physical and organization facilities needed to support the operation of farm enterprise.

### **EXAMPLES OF AGRICULTURAL INFRASTRUCTURE**

These include

1. Transport networks such as roads and bridges, rail networks and pedestrian walkway.
2. Communication systems such as postal, telephone, interne, television and radio stations.
3. Water supply system.
4. Power(electricity)supply system
5. Food storage facilities such as the network of grain silos located in the regions and districts.
6. The networks of agricultural experiment centres and research stations spread throughout the country.

7. The networks of ADMARC markets and cattle markets located in all extension areas.
8. Livestock protection infrastructures such as the networks of dip tanks.

### **IMPORTANCE OF AGRICULTURAL INFRASTRUCTURES**

Agricultural infrastructures are important in the following ways:

1. They facilitate the transportation of farm inputs.
2. They increase yields in agriculture through irrigation which helps the farmers to obtain high yields.
3. They enable the transportation of farm inputs to markets.
4. They promote the use of improved technology through rural electrification which helps farmers to use motorized water pumps for irrigation to increase production.
5. They attract and support manufacturing companies to set their industries near farmers. This encourages farmers to increase crop and livestock production.
6. They promote agricultural trade through good communication systems.
7. They facilitate dissemination of agricultural information when roads are good.
8. They improve farm income through reducing transportation costs (through good transport system), production and marketing costs

### **EXAMPLES OF AGENCIES THAT PROVIDE INFRASTRUCTURE SERVICES TO SUPPORT AGRICULTURE IN MALAWI**

These include

- Rural Infrastructure Development Programme (RIDP) which focuses on roads and irrigation infrastructures.
- Ministry of Transport and Public Infrastructures
- National Roads Authority
- Malawi Rural Development Fund (MARDEF)
- Ministry of Irrigation and Water Development
- Department of Veterinary Services
- National Water Development Programme

#### **4. AGRICULTURAL EXTENSION SERVICES**

Agricultural extension services can be defined as

- a. System of transferring information from the researcher to farmers.
- b. Way of taking fact knowledge from research stations to farming families.
- c. Means of bringing messages/advice from technologist farmers' groups
- d. Mechanism of disseminating skills /methods from experimentations to farming communities.
- e. Structure of communication of practices/recommendations from scientific studies to rural farming societies.

#### **THE ACTIVITIES/ROLES OF AGRICULTURAL EXTENSION AGENCIES**

- a. Advertising smallholder farmers on particular enterprises to increase production or quality of products.
- b. Training farmers to change their attitudes and improve their knowledge and skills as farmers.
- c. Conducting campaigns where new technologies are displayed in order to attract and persuade farmers to try them out in their fields.
- d. Performing methods or results demonstration as a way of persuading or influencing farmers to adopt new ideas, practices, techniques and recommendations.
- e. Arranging field days in extension planning areas to raise awareness of recommended practices and encourage farmers to use them in their fields.
- f. Producing agriculture publications such as posters, pamphlets, leaflets and magazines to farmers to read. Za Achikumbe is distributed by the Agricultural Communication Branch.
- g. Holding agricultural shows and exhibits where farmers display their products and learn from one another how the items are produced.
- h. Airing farm radio broadcast for farmers to listen to e.g. Ulimi Wa Lero on MBC.
- i. Producing films and puppet shows to persuade farmers to adopt new technologies.

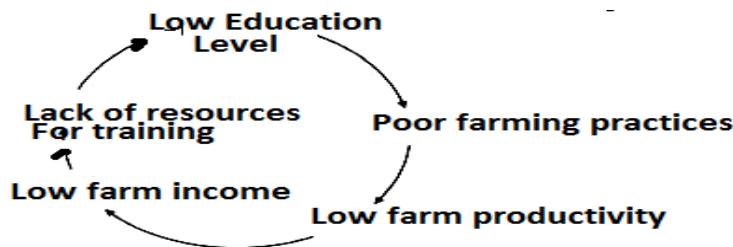
j. Conducting farmers' group meetings to discuss important agricultural practices.

**EXAMPLES OF THE MAIN AGRICULTURAL AGENCIES IN MALAWI**

- a. The Department of Agricultural Extension Services which works through the agricultural communication branch, agricultural development divisions, district agricultural development offices and the extension planning areas.
- b. Non Governmental Organizations. These include
  - Development Aid From People to People (DAPP)
  - Hunger Project and Concern Universal
- c. Private Extension Companies e.g.
  - National Smallholder Farmers Association of Malawi (NASFAM)
  - The One Aere Fund
  - The Smallholder Coffee Farmers 'Trust
  - The Horticultural Development Organization of Malawi
  - Wellness for Agriculture and Life Advancement (WALA).
- d. Manufacturers and Suppliers of Agricultural Inputs such as fertilizers, pesticides, herbicides, feeds, and drugs and agricultural equipments who offer advice to farmers at the point of sale on how to use products. Examples of such agencies include Agricultural Trading Company, Proto Feeds Ltd and Charles Stewart Day Old Chicks Ltd

**IMPORTANCE OF AGRICULTURAL EXTENSION TO THE GROWING POPULATION**

- a. Bringing scientific knowledge to farmers
- b. Improving technology adoption by farmers.
- c. Improving productivity of agricultural land.
- d. Developing capacity of farmers through training
- e. Breaking the vicious cycle of poverty in rural areas



**HOW DOES EXTENSION BREAK VICIOUS CYCLE**

This is done by

- a. Training the farmers
- b. Improving the welfare of farming families
- c. Promoting income distribution
- d. Promoting sustainable use of farming resources

**5. PROCESSING SERVICES**

Processing involves changing the form of agricultural produce or raw materials to a form which consumers prefer.

**IMPORTANCE OF AGRICULTURAL PROCESSING SERVICES TO THE GROWING POPULATION**

- a. They create market where farmers can sell their produce and obtain an income which encourages farmers to produce more for growing population.
- b. They add value to the produce so that farmers can gain more from selling the products.
- c. They provide employment to the growing population engaged in processing the produce.
- d. They increase shelf life of the produce so that it can be kept in storage for long periods without loss in quality, for the growing population to enjoy.
- e. They improve the taste of edible produce for the growing population.

**EXAMPLES OF PROCESSING AGENCIES/COMPANIES IN MALAWI**

<b>PROCESSING AGENCIES</b>	<b>RAW MATERIALS)</b>	<b>PRODUCTS PROCESSED</b>
Universal Industries Ltd	Cassava, groundnuts	Crisps
	Groundnuts	Butter, Tambala nuts
Malawi Dai-ry Industries	Milk	Yorghurt, Butter, Cheese
Bakhressa Malawi Limited	Maize	Stock feeds
Rab Processors Limited	Maize	Stock Feeds/Snow White Ufa Oyera
	Rice	Milled

Chibuku Breweries	Maize	Stock beer
Nail-	Chilies, Pepper	Abale Samalani Hot Chill
	Tomatoes	Tomato Sauce
Agro-Feed Limited	Maize, Soya Beans	Stock Feeds
Malawi Mangoes Ltd	Mangoes, Bananas	Fruit Juice

## 6. PRODUCTION CREDIT SERVICES

Agricultural credit is defined as the amount of money that a financial institution is prepared to lend a farm.

### IMPORTANCE OF AGRICULTURAL CREDIT

Agricultural credit is important in the following ways

- a. Increasing agricultural production if it is used to buy the inputs which increases crop yield.
- b. Increasing income per yield of given resources if the credit is invested it to increase the output per animal.
- c. Improving nutrition and food security among farmers because high farm income enables farmers to buy nutritious food for their families.
- d. Improving welfare farmers through increasing farm income which helps farmers to pay for the necessities for family such as medicines and household goods.
- e. Increasing employment opportunities for rural people through the credit helps farmers to expand thereby employing more workers.
- f. Employing the poverty cycle among farmers.

### EXAMPLES OF AGENCIES THAT PROVIDE CREDIT IN MALAWI

These include-

- a. Commercial -Banks such as National Bank of Malawi
- b. Cooperative Societies such as Savings and Credit Cooperative Societies (SACCO).
- c. Malawi Rural Finance Company. Its branches are located in every (EPA).
- d. One Acre Fund.

e. Non-Institutional Agencies such as traders, friends and relatives.

## **IMPORTANCE OF THE AGRICULTURAL DEVELOPMENT AGENCIES TO THE GROWING POPULATION**

Agricultural agencies are important to the growing population in Malawi the following ways:

### **1. They promote food security**

They help farmers to use improved inputs and methods of growing crops and raising livestock for high yields to make more food available to the growing population.

### **2. They improve cash income for rural farmers**

They do this by promoting modern farming technologies and practices to make agriculture more profitable.

### **3. They increase raw material production for agro-based industries**

This is done by supporting by supplying farmers with farm inputs to increase their yields.

### **4. They improve employment opportunities**

When the people are employed on the farms and the urban population is able to find jobs in the agro-based industries.

### **5. They improve government revenue**

The government charges taxes on the revenues of the farmers obtained after selling the increased yields. The government uses the amount obtained from taxes to build fund public services such as hospitals and schools.

### **6. They help to- increase foreign reserves**

The increased exports made by the produce that are exported to other countries, the government is able to obtain more foreign currencies. They regulate production levels of certain crops in order to raise prices.

### **7. They provide credit facilities to farmers**

This helps farmers to increase the volume of production and hence more food for the growing population

8. They encourage bulk selling of commodities by small scale farmers.

This helps farmers to earn more income to meet the domestic demands.

#### **CHAPTER FOUR: FARM RECORDS**

Budgeting is a process which deals with identifying activities to be performed and estimating the income to be obtained from such an activity and its associated costs in order to achieve the intended outcome.

**Farm records** can be defined as

- An outline of estimated future income and expenditure on the farm.
- The systematic entries of various farm business activities and transactions which include data on finances and inventory the farm has for certain period of time.

#### **REASONS FOR KEEPING FARM RECORDS**

1. They are important tool in budgeting for farm activities
2. They help the farmer in planning and budgeting in order to make appropriate choices and decisions on the farm.
3. They provide history of what has been happening on the farm thereby used for comparison.
4. They are required by financial institution before any loan can be approved to determine the need and capacity of the farmer to repay the loan as well as to determine whether the farmer can benefit from the credit if advanced.
5. Adequate farm records help the farmer to avoid being overtaxed since tax is based only on the actual farm profits.
6. They help the farmer to determine the financial status of the farm.
7. They help the farmer in proper management of various routine livestock or crop production practices such as dates of harvesting, vaccination, calving etc.
8. They help the farmer to make comparison of the relative profitability of different crops and livestock and to suggest which enterprises should be expanded and which one should be reduced or even eliminated to increase farm profits.

#### **TYPES OF FARM RECORDS**

These include

1. Inventory records
2. Production records
3. Financial records

### **INVENTORY RECORDS**

- These are farm record that shows the list of all assets of the farm which include fixed assets like buildings, sheds and fences, machinery, equipments/tools and livestock.
- Inventory refers to the list of all assets of the farm.
- Inventory records should be taken at the end of farming year usually in September when there is less work on the farm.
- Examples of assets that are found on the farm
  - a. Land
  - b. Buildings such as warehouses, barns, granaries, sheds etc
  - c. Machineries
  - d. Produce in storage
  - e. Livestock
  - f. Inputs such as fertiliser bags, seeds, pesticides and herbicides

### **WHAT ARE THE STEPS INVOLVED WHEN TAKING AN INVENTORY?**

The following are the steps involved when taking inventory

1. Counting the items physically.
2. Making physical measurement of all items such as size of land, buildings and other structures and available crops.
3. Estimating the value of assets using the present market prices. When estimating the present value of assets, it is important that the farmer must consider the loss of value of the item (depreciation) over period of time (lifespan of an item- the period an item is expected to be in use).

### **TYPES OF ASSETS/INVENTORIES**

1. **Current assets/consumables**

- They are those assets that are used up within the short term possibly a growing season.
- They include inputs like fertilizers, seeds, feeds as well as crop yields and livestock products.

## **2. Fixed assets/permanent goods**

- Fixed assets are those items that are used in the day -to-day running of the farm.
- They are normally stay in the farm business for a very long time that span over one growing season.
- Examples of fixed assets are land, buildings, machineries, tools and implements
- Most of the fixed assets have a characteristic that they tend to lose value as time as time pass by. This loss in the value of fixed assets is called **depreciation**.

### **CAUSES OF DEPRECIATION**

- a. Physically deterioration through rusting caused by exposure to rain etc, wear and tear as the asset is being used.
- b. Obsolescence where an asset becomes out of use due to changes in technology or inadequacy.
- c. Depletion
- d. Time

### **EXPLAIN THE BENEFIT OF CALCULATING DEPRECIATION ON A FARM**

As it has been earlier noted, depreciation represents a reduction in value for a fixed asset. For this reason, it is necessary to include charges of depreciation when calculating the net value of a farm business because any reduction in the value of an asset is a cost or loss to the business. Therefore, calculating depreciation for an asset helps the farmer to ascertain the true picture of the farm business.

### **METHODS OF CALCULATING DEPRECIATION**

#### **1. STRAIGHT-LINE METHOD**

- Straight line depreciation is when the value of asset is reduced by fixed equal amounts over the life of the asset.

**Annual Depreciation**  $\frac{(\text{Cost of asset}) - (\text{Estimated salvage or scrap value})}{\text{Useful life}}$

**Where**

- ❖ **Cost of asset** is the initial amount paid to acquire the asset.
- ❖ **Scrap Value** the value at which the asset is to be disposed of after use or  
**Scrap value** is the residual value of an asset after its useful period and is usually measured by how much it can fetch if sold after its useful life. It is also called **residual, salvage or net book value**
- ❖ **Annual depreciation value** is the amount of depreciation charged each year under straight line depreciation.

**EXAMPLE**

The office machinery depreciates from its assumed value of K9, 000 over the next five years and its estimated salvage value is K4, 500. Determine its new value at the end of each year, using the straight line method by working out the depreciation charges for the five years.

$$\begin{aligned} \text{Annual depreciation} &= \frac{(\text{Cost of asset}) - (\text{Estimated salvage or scrap value})}{\text{Useful life}} \\ &= \frac{\text{K9,000} - \text{K4,500}}{5 \text{ years}} \\ &= \text{K900 per year} \end{aligned}$$

<b>Year end</b>	<b>Straight line Annual Depreciation (K)</b>	<b>Book Value at the end of Each year</b>
1	K900	K9,500 - K900 = K8,600
2	K900	K8,600 - K900 = K7,700
3	K900	K7,700 - K900 = K6,800
4	K900	K6,800 - K900 = K5,900
5	K900	K5,900 - K900 = K5,000

**2. REDUCING BALANCE METHOD**

Under reducing balance method, the scrap value varies from year to year.

**EXAMPLE**

A farmer purchased farm machinery for K2, 000,000 .Calculate the value of the machine after 4 years if it is depreciated by 10% per year using the reducing balance method.

<b>Year</b>	<b>Amount of depreciation per year</b>	<b>Remaining balance/Book value year end</b>
1	$2,000,000 \times 10\% = K2,00,000$	K2,000,000-K200,000=1,800,000
2	$1,800,000 \times 10\% = K180,000$	K1,800,000-K180,000 =1,620,000
3	$1,620,000 \times 10\% = K162,000$	K1,620,000- K162,000=K1,458,000
4	$1,458,000 \times 10\% = K145,800$	K1,458,000-K145,800 =K 1,312,200

### AN EXAMPLE OF FIXED INVENTORY RECORDS

#### Fixed Asset Record

<b>Item</b>	<b>Quantity</b>	<b>Cost</b>	<b>Depreciation</b>	<b>Net Book Value</b>
Buildings	40 ha	K5,000,000	-	K5,000,000
Motor vehicles	9	K2,500,000	K100,000	K2,490,000
Fixtures and Fittings	4	K1,200,000	K5,000	K1,195,000
Plant and machinery	18	K250,000	K12,000	238,000
Tools and implements	-	K175,000	K3,000	K172,000

### **3. PRODUCTION RECORDS/OPERATION RECORDS**

- They are used to keep details about activities involved when producing farm produce, the inputs that are used and the output that is obtained.
- Production records show raw amount of yield from crops and animals.
- They tell the farmer the inputs used in producing a crop or raising animals and the farm produce or outputs.
- Farmers use both variables which vary with crops grown and animal raised. Fixed costs are used for a long time such as buildings and equipments, permanent labour.
- Example of production records that a famer can keep are shown below.

<b>Date</b>	<b>No. of Layers</b>	<b>No. of eggs collected</b>	<b>No. of broken eggs</b>	<b>No. of eggs not broken</b>	<b>Laying percentage</b>	<b>Remarks</b>
2/05/2018	300	250	40	210	83	Low yield

- Farm produce are also production records. The actual weight of crops and animal yield such as kgs of beans and kgs of meat animal , litres per animal etc
- By comparing the yield and inputs, the farmer is able to work out gross margin and profit for various enterprises.

### **TYPES OF PRODUCTION RECORDS**

#### **1. CROP PRODUCTION RECORDS**

- These include crop enterprise records and field operations records

##### **A. CROP ENTERPRISE**

- The crop enterprise records include details on
  - Type of enterprise
  - Size of land
  - Type of inputs used and their quantities
  - Costs of inputs
  - Amount of output produced

##### **Example of A crop enterprise record**

Type of crop	Plot No	Size of land	Seed rate(kg)	Spacing date	Harvesting date	Yield (kg)	Remarks
Maize							
Tobacco							
Pigeon peas							
Cotton							

##### **B. FIELD OPERATIONS RECORDS**

These are used to keep details of all operations conducted in producing a particular crop.

##### **Example**

FIELD OPERATIONS RECORD				
Plot No.....		Land Size.....	Year/Season.....	
Type of crop.....		Variety.....	Seed rate.....	
Activity		Yield/ha.....		
Planting				
Fertiliser				

application				
Weeding				
Top dressing fert				
Weeding				
Disease control				
Harvesting				

## **2. LIVESTOCK PRODUCTION RECORDS**

- The type of livestock production records kept depends on the nature of farm animals that are being reared on the farm.
- The general examples of livestock production records include the following

### **A. Livestock number records**

These or tables contain information relating to the following:

- Type of animal
- Number born
- Number bought or received
- Number dead or slaughtered
- Total number of animals
- Number sold

### **B. Feeding records**

They or the tables contain information on

- Type of feed
- Number of animals
- Quantity bought
- Cost of feed
- Amount issued
- Balance in stock

### **C. Breeding records**

They keep details on

- Breed of animal
- Date of service

- Expected calving rate
- Actual calving date
- Weight of calf at birth
- Sex of calf etc

#### **D. Livestock Health records**

They contain details pertaining all issues affecting livestock health such as

- Date when illness or parasites are noticed
- Name of the disease
- Treatment given
- Cost of treatment
- Results of treatment

#### **E. Meat production records**

These keep details on:

- Age of the animal
- Name of animal
- Live weight of the animal;
- Dressed weight
- Amount of money realized

#### **F. Milk production records**

They include details such as

- Date, month and year
- Name of cow
- Amount of milk collected during morning and afternoon times
- Total amount of milk per month etc

#### **G. Egg production record**

Details include

- Number of birds
- Number of eggs collected per day

### **4. LABOUR RECORDS**

These are records that keep track of all the labour used on the farm. It keeps details on:

- Type of workers employed such as men, women, children
- Number of people employed
- Number of days worked
- Farm activity performed
- Amount of money paid

The input of labour used on the farm is calculated in units called man days.

In a month of 25 working days, the amount of labour that can be provided by respective categories of workers is as follows:

<b>Category</b>	<b>Amount of labour</b>
Man	25 man days (1 man day per day)
Woman	17 man days (0.7 man days per day)
Child	7 man days (0.3 man days per day)

### **EXAMPLE**

The table below shows a field operations record

Dates		Activity	Number employed	No of days Worked	Remarks
From	To				
16/08/2019	19/09/2019	Clearing	3 children, 2 women , 1 man	3	Satisfactory
30/08/2019	10/09/2019	Ridging	1 child, 1 woman , 4 men	8	Good job, some days not worked
13/12/2019	15/12/2019	Planting	4 children, 1 woman , 1 man	2	Timely done

### **Required**

- Calculate the number of man days for clearing the land.

### **Clearing:**

$$= \{(3 \text{ children} \times 0.3 \text{ man days}) + (2 \text{ women} \times 0.7 \text{ man days}) + (1 \text{ man} \times 1 \text{ man day})\} \times 3 \text{ days}$$

$$= \{(0.9 + 1.4 + 1) \text{ man days} \times 3 \text{ days}\}$$

$$= 3.3 \text{ man days} \times 3 \text{ days}$$

$$= 9.9 \text{ man days}$$

From the calculation, the total labour input labour input for clearing the land in 3 days using 3 children, 2 women and 1 man is 9.9 man day units.

#### QUESTIONS FOR REVIEW

- b. Calculate the number of man days for

- (i) Ridging
- (ii) Planting

#### LABOUR PROFILE

- Labour profile is the histogram that is constructed to show than man days per month for an enterprise.
- Labour peak is the period when there is high labour demand on the farm compared to the labour supply available to carry out farm operations
- Labour trough is the period when there low labour demand on the farm compared to labour supply available to carry out farm activities.

#### EXAMPLE

A family has a total supply of labour of 40 man days per month. Below is a table showing labour demand for one hectare of maize in man days per month.

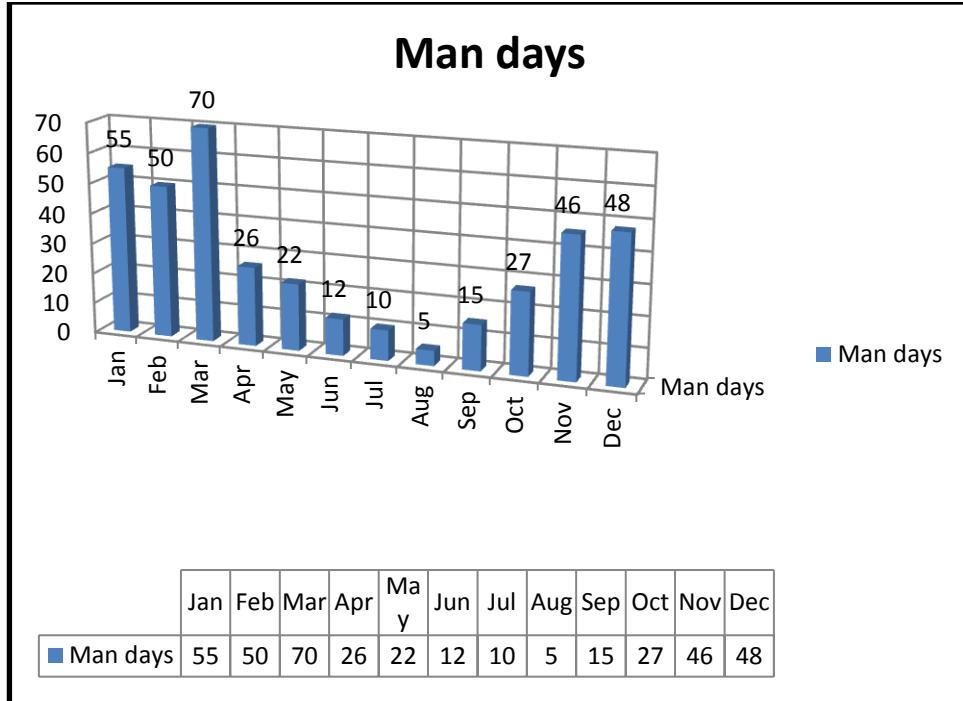
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Man days	55	50	70	26	22	12	10	5	15	27	46	48

Required

- a. Construct a labour profile in a histogram for maize enterprise.
- b. Mention the months during which the family can manage the amount of work available.
- c. Which months does the enterprise experience peak periods
- d. Mention the activities on the maize enterprise that can lead to peak periods.
- e. Explain two ways in which you would manage the peak periods.

#### ANSWERS

- a. Histogram showing Labour profile for the maize enterprise



- b. The family can manage the amount of work available in the months of April, March, June, August, September and October. During these months the man days required per month are below 40 man days against the supply.
- c. Maize enterprise experience peak period during the months of January, February, March, November and December.
- d. The following activities can lead to peak periods: Ridging, planting, weeding, and fertiliser application
- e. Two ways in which the peak periods can be managed include
  - Employing casual labour
  - Using the elderly people on the farm

### **FINANCING RECORD AND ACCOUNTS**

- These are records of all financial transactions that have occurred. They include all purchase of farm inputs and other expenditures such as wages and salary payments, rent, electricity bills and all sales including services rendered such as machinery hire.
- Examples of financial records include
  - a. Income records
  - b. Expenditure records

- c. Trading accounts
- d. Debtors and creditors- Debtors are people who have collected farm produce to pay while creditors refer to the organisation or people who could be owed money by the farm. Farmers collect inputs to them later.

### **CHAPTER FIVE: BUDGETING**

Budgeting is a process which deals with identifying activities to be performed and estimating the income to be obtained from such an activity and its associated costs in order to achieve the intended outcome.

Farm budgeting is defined in the following ways:

- a. It is the physical aspects of farm planning when expressed in monetary terms
- b. It is the expression of a farm plan in monetary terms by estimation of receipts, expenses and income.
- c. It is a process of estimating cost, returns and net profit of a farm or a particular enterprise.

### **REASONS WHY FARMERS PREPARE BUDGETS FOR ALL FARM ACTIVITIES**

- 1. To examine if producing a particular enterprise will be profitable or not.
- 2. To estimate the quantity and costs of inputs to be required.
- 3. To enable the farmers to mobilize and allocate resources for all farm operation
- 4. To assist in formulation of farm plans for efficient allocation of resources.

### **TYPES OF FARM BUDGET**

**There are three types of farm budgets which include**

- a. Partial budget
- b. Break-even budget
- c. Complete budget

#### **PARTIAL BUDGET**

- Partial budget is the budget that seeks to examine the effect of a change on the profitability of a given farm enterprise.
- Partial budget can also be defined as an estimation of the return for a part of business, that is, one or few activities.

- Partial budget is prepared , for example, to
  - a. evaluate the consequences of changes on an enterprise or enterprise mixes that affect only part or the whole farm
  - b. To estimate additional costs and returns from growing one hectare of hybrid maize in place of local maize.
  - c. To estimate additional cost and returns by adopting foliar application of chemical fertilizers instead of soil application.

To achieve these objectives, partial budget assesses the expected marginal returns that would result from the changes. For this reason, a partial budget only considers the **variable costs**.

- The following important questions must be borne in mind when preparing partial budget:
  - a. What extra cost is to be incurred?
  - b. What present/existing income or revenue is to be forgone or given up?
  - c. What present costs will no longer be incurred?
  - d. What extra income is to be earned?

### **UNDER WHAT CIRCUMSTANCES DO FARMERS PREPARE PARTIAL BUDGETS**

- a. When intending to substitute one enterprise with another one.
- b. When expanding or downsizing production
- c. When a farmer wants to change method of production

### **THE COMPONENTS OF PARTIAL BUDGET**

1. Increase in income
2. Reduction or elimination of costs
3. Increased in costs
4. Reduction or elimination of costs

#### **When partial budget is prepared:**

##### **a. A positive net change**

This indicates that the farm income will increase due to change and farmer can change the enterprises since it is profitable.

**b. A negative net change**

This indicates the change will reduce the farm income so a farmer should not just maintain the original enterprise.

**SECTIONS OF THE PARTIAL BUDGET**

**1. Section 1**

This contains additional costs that will be incurred as a result of growing a new commodity or using a new practice.

**2. Section 2**

This will show the benefits which are the additional returns that will be received as a result of growing a new commodity or using a new practice.

**3. Section 3**

This is the analysis section where either **Net Change in Profits** will be established by subtracting **Total Costs** from **Total Benefits** or **Benefit Costs** will be obtained by dividing **Total Benefits** by **Total Costs**.

**Net Change in Profits = Total Benefits - Total Costs**

**Benefit Costs = (*Total Benefits*) / (*Total Costs*)**

**THE STEPS IN PREPARAING A PARTIAL BUDGET**

1. Estimating the total income by adding
  - a. Saved costs
  - b. Extra income
2. Estimate the total cost or expenditure by adding
  - a. Foregone income/revenue
  - b. Extra costs
3. Compare the expected income and expected expenditure. If the income is higher than the costs, the change is likely to be profitable. If the expected costs are higher than income, the change is likely to result into a loss

**FORMAT FOR PARTIAL BUDGET**

<b>PROBLEM (PROPOSED CHANGE)</b>			
<b>Section 1 (Extra Costs)</b>	(K)	<b>Section 2 (Additional Returns)</b>	K
<b>A. Extra cost:</b> List of <b>additional costs</b> incurred as a result of growing a new commodity or using a new practice		<b>B. Extra Income:</b> List of <b>additional benefits</b> that will be received as a result of growing a new commodity or using a new practice.	
<b>Sub-Total</b>		<b>Sub-Total</b>	
<b>C. Opportunity Cost</b>		<b>D. Saved Costs</b>	
<b>Reduced return/opportunity costs</b> that will be given up as a result of no longer producing the current commodity being grown or practice being used		Reduced costs that will no longer incurred as a result of giving up the current commodity or practice for a new one.	
<b>Total Costs (A + C)</b>		<b>Total Benefits (B + D)</b>	
<b>Section 3: Analysis</b>			
Net Change in Profits = <b>Total Benefits - Total Costs</b>			
Benefit Costs = <b>(Total Benefits)/(Total Costs)</b>			

**EXAMPLE 1**

Mr Banda has two hectares of land on which he grows NSCM41. He however wants to make the following changes.

- To apply 4 bags of urea instead of 6 bags per hectare at K1,300 per hectare.
- To sell 40 bags of Maize at K1, 000 per bag to Chibuku Products Limited instead of K850 per bag to ADMARC.
- To store maize in 50 sacks at K30 each instead of storing it in the Nkhokwe.
- To spend K500 instead of K300/ha on actellic.
- To spend K600/ha instead of K300/ha on casual labour.

**Required**

- Prepare a partial budget for Mr Banda.
- Should Mr Banda go ahead with his plans? Explain.

**a. Preparation of budget for Mr Banda's changes on his farming activities**

Costs	K	Gain/Income	K
<b>Extra costs</b>		<b>Extra income</b>	
Urea (4 bags x K1,300/bag)	K10,400	Maize (40 bags x K1,000/bag)	K40,000
Actellic	K500		
Casual labour (2 labors x K600/Labor	K1,200		
Sacks (50 sacks x K30/sack)	K1,500		
<b>Subtotals</b>	K13,600		K40,000
<b>Opportunity Costs</b>		<b>Saved Costs</b>	
Maize (40 bags x K850/bag)	K34,000	Urea (4bags x 2ha x K1,300/ha)	K15,000
		Casual labour (2 labors x K300/L)	K600.00
		Actellic	K300.00
		Nkhokwe	Nil
<b>Total Cost</b>	K47,600	<b>Total income</b>	K56,000
<b>Net Change in Profit = Total Benefits - Total Costs</b>			
<b>= K56,000-K47,600</b>			
<b>= K8,400</b>			

- Mr Banda should introduce the change because total incomes from the change outweigh the total cost. The net change is positive which indicates that the change is profitable to Mr Banda.

**EXAMPLE 2**

A farmer intends to produce 4000kg of maize instead of tobacco. The inputs required to produce maize include 12 bags at K12, 500 per bag, maize seeds at K43, 000, pesticides at K8,000, casual labour at K106,000, storage expenses at K11,000 and packaging materials at K18,000.

For tobacco production, the farmer was spending K15, 000 per bag for 8 bags of fertiliser, K45, 000 for chemicals, K80, 000 for grading, K25, 000 for seeds and K150, 000 for transportation.

Assuming that the price for maize is K230 per Kg and K440 per kg for tobacco, prepare a partial budget.

### **A PARTIAL BUDGET**

<b>DR</b>		<b>CR</b>	
<b>INCOME</b>	<b>K</b>	<b>COSTS</b>	<b>K</b>
<b>Saved Costs:</b>		<b>Extra Costs</b>	
Fertiliser (8 bags x K15,500/bag)	124,000	Fertiliser (12 bags @K12,500/bag)	150,000
Maize seeds	25,000	Seeds	43,000
Chemicals	80,000	Pesticides	8,000
Transportation	150,000	Casual labour	106,000
		Storage	11,000
		Packaging	18,000
<b>Sub-Total</b>	<b>420,000</b>		<b>336,000</b>
<b>Extra income</b>		<b>Foregone income</b>	
4000 kgs of maize x K230/kg	<b>920,000</b>	2500kg of tobacco x 440/kg	<b>1,100,000</b>
Loss	<b>92,000</b>		
<b>Total costs</b>	<b>1,344,000</b>	<b>Total income</b>	<b>1,436,000</b>
<b>Net Loss = K1,436,000 - 1,344,000</b>			
<b>= K92,000</b>			

#### **Comment**

The farmer should be advised to make a change since the production of maize instead of tobacco would lead to a loss of K92, 000.

#### **THE USES OF PARTIAL BUDGET**

1. It helps the farmer to introduce a new enterprise without necessarily changing other enterprises.

2. It helps the farmer to change one enterprise for another /to bring about substitution.
3. It helps the farmer to expand the existing enterprise or to make additions to existing enterprises, for example, increasing the area for crops or livestock held for beef, broiler, dairy, egg production, sheep, goats etc.
4. It helps the farmer to adopt a change in method of production. For example, introducing a milking machine instead of hand milking.
5. It helps the farmer to anticipate government's program.

### **THE LIMITATIONS OF THE PARTIAL BUDGET**

1. It is restricted to evaluating only two alternatives.
2. The results obtained from partial budgets are only estimates and are only good as the original data is entered. When inaccurate information is entered, inaccurate information is received.
3. It does not account for the value of money and in future.
4. It only provides an estimate of the profitability of an alternative to current operations but does not provide estimate of the absolute profitability of the business.
5. It does not include the costs and returns that are not affected by the intended change.

### **COMPLETE BUDGET/WHOLE FARM BUDGET**

- Complete budget is the budget that looks into every detail of the farm that includes both **fixed costs** and **variable costs** and is prepared when the farmer wants to start a farming system business.
- It is prepared for **short run (annual budget)** and **for a run**.

### **FIXED COSTS**

- **Fixed costs-** Fixed costs are the type of production cost that remains constant regardless of the increase in the level of business activities/output within a given period of time. Fixed cost must be incurred even if production output is zero. Examples are rental fees for lease, interest payable on loans, insurance

premium, depreciation of machineries and buildings, payment of salaries, utility bills like water, electricity etc.

- Fixed costs affect the whole farm. They are incurred even if production is not taking place on the farm.
- Fixed costs are deducted from gross profit to get net profit

**Net Profit = Gross Profit - Fixed Costs**

#### **VARIABLE COSTS**

- **Variable costs**– Variable costs are those costs in a cost function that change with respect to rate of change of the firm's output.
- These may include wages; agricultural inputs such as pesticides, fertilizer, drugs, seeds and payment of casual labour etc.
- Variable costs are enterprise specific. This means that they only affect a given farm enterprise and not the whole farm.
- Variable costs are used to ascertain the gross profit of an enterprise.

**Gross Margin= Gross income- Variable Costs**

- **Net Profit =Gross Margin - Fixed Costs**

#### **TOTAL COSTS**

- Total costs are made up of variable costs and fixed costs

**Total Costs = Total Variable Costs + Total Fixed Costs**

#### **WHEN SHOULD A FARMER PREPARE COMPLETE BUDGET?**

Complete budget is prepared for

- A new farm
- Carrying out major changes on the farm
- Purchase new equipment
- Compare financial effect of proposed change with the present system.
- When drastic changes are suggested in the plan of the existing pattern on established farm.

#### **WHAT ARE THE STEPS THAT ARE INVOLVED WHEN PREPARING COMPLETE BUDGET?**

1. A farmer should decide on what to produce based on farmer's skills.

2. Making an estimate on input requirements
3. Making a estimate on the expected yield
4. Making an estimate on the prices for the yield.
5. Making an estimate on fixed costs of buildings, machinery depreciation etc.
6. Calculating the total costs (Total Fixed Costs and Variable Costs)
7. Calculating the Total Revenue/Gross Income
8. Calculating Net Revenue

**Note**

- The budget variable costs for the enterprise should be clearly shown
- Gross profits /margins should be added so as to subtract the fixed costs
- All fixed cost items should be listed.

**EXAMPLE 1****Given the following information:**

The farmer sold 400kg of Maize at K400/kg, 450kg of Cassava at K50/kg, 800kg of tea at K200/kg and 2000kg of Rice at K25/kg that he harvested from his farm.

**Variable costs for each enterprise incurred:**

	Maize	Cassava	Tea	Rice
Seeds and fuel	K,000	K500	K800	K500
Fertilizer	K8,000		K10,000	K20,000
Pesticides	K5,000	K150	K1,000	
Casual labour	K100	K150	K200	K80

**Fixed costs incurred include:**

	Maize	Cassava	Tea	Rice
Regular Labor	K20,000	K20,000	K20,000	K20,000
Rental & Fuel	K5,000	K5,000	K5,000	K5,000
Depreciation	K250	K250	K250	K250
Repairs	K3,000	K3,000	K3,000	K3,000
Land tax	K3,000	K3,000	K3,000	K3,000
Loan Interest	K2,000	K2,000	K2,000	K2,000
Administration Expenses	K1,000	K1,000	K1,000	K1,000
General overheads	K8,000	K8,000	K8,000	

**Required**

- a. Find the two crop enterprise that has the highest gross margin
- b. Which crop would you advise the farmer to grow you mentioned in a above?
- c. Why would you advise a farmer to grow the crop you have mentioned in a above?
- d. Which crop would be the worst for the farmer to grow?
- e. Calculate the whole farm gross margin
- f. Work out the whole farm profit.

**ANSWER**

	Maize		Cassava		Tea		Rice	
	K			K		K		K
Yield(kg/ha)		400		450		800		2000
Price (K/kg)		K200		K50		K200		K25
<b>Total Gross Income</b>		<b>K80,000</b>		<b>K22,50</b>		<b>K160,000</b>		<b>K50,000</b>
<b>Less Variable Costs</b>								
Seeds and fuel	K1,000		K500		K800		K500	
Fertilizer	K8,000				K10,000		K20,000	
Pesticides	K5,000		K150		K1,000			
Casual labour	K100		K150		K200		K80	
<b>Total variable costs</b>	<b>K14,100</b>	<b>-K14,100</b>	<b>K800</b>	<b>-K800</b>	<b>K12,000</b>	<b>-K12,000</b>	<b>K20,580</b>	<b>-K20,580</b>
<b>Gross Margin/ha</b>		<b>K65,900</b>		<b>K21,700</b>		<b>K148,000</b>		<b>K29,420</b>
<b>Less Fixed costs</b>								
Regular Labor	K20,000		K20,000		K20,000		K20,000	
Rental & Fuel	K5,000		K5,000		K5,000		K5,000	
Depreciation	K250		K250		K250		K250	
Repairs	K3,000		K3,000		K3,000		K3,000	
Land tax	K3,000		K3,000		K3,000		K3,000	
Loan Interest	K2,000		K2,000		K2,000		K2,000	
Administration	K1,000		K1,000		K1,000		K1,000	
Overheads	K8,000		K8,000		K8,000			
<b>Total Fixed Costs</b>	<b>K42,250</b>	<b>K42,250</b>	<b>K42,250</b>	<b>K42,250</b>	<b>K42,250</b>	<b>K42,250</b>	<b>K42,250</b>	<b>K42,250</b>
<b>Net Profit/(Loss) (K)</b>		<b>K23650</b>		<b>(30250)</b>		<b>105,750</b>		<b>(12,830)</b>

- a. The two crops that have the highest gross margin are Tea and Maize.
- b. The farmer would be advised to grow Tea
- c. Tea would give the farmer the highest gross margin and at the same time the highest net profit.
- d. The worst crop for the farmer is cassava.
- e. The gross profit for the whole farm

$$\text{Gross profit} = K65, 900 + K21, 700 + K148, 000 + K29, 420$$

$$= K265, 020$$

- f. Net Profit for the whole farm:

$$\text{Net Profit} = K23650 + -K30250 + K105, 750 + -K12, 830$$

$$= K86, 320$$

### **Example 2**

Given the following information of Friesian Cattle breed:

Total cost of feed	K10, 000.00
Veterinary costs	K1, 500.00
Cost of "Khola"	K5, 000.00
Income obtained	K40, 000.00

Calculate the gross margin for the Friesian cattle breed. Show your working.

	K	K
Income		40,000
Less Variable costs		
Total cost of feed	10,00	
Veterinary costs	1,500	
Cost of khola	5,000	16,500
<b>Gross margin</b>		<b>23,500</b>

### **Example 3**

A farmer has 10 hectares and has a choice of growing either more maize or groundnuts.

The following information is available for use in decision making.

## FORM THREE AGRICULTURE COMPREHENSIVE STUDY NOTES -NEW SYLLABUS BASED)

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	Maize	Groundnuts	Beans
Yield (kg/hectare)	6,000	2,000	2,500
Price (Kwacha/kg)	30	50	40
Cost of seed/hectare	K500	K1,200	K1,000
Cost of fertiliser/hectare	K2,400	-	K2,000
Depreciation of Nkhokwe /year	K500	K500	K500

Required

- Calculate the gross profits for each crop. Show your workings
- Which crop between maize and groundnuts would the farmer be encouraged to increase hectarage?

### Calculating gross profits and net profits

	Maize	Groundnuts	Beans
Yield (kg/hectare)	6,000	2,000	2,500
Price (Kwacha/kg)	30	50	40
Total income	<b>K180,000</b>	<b>K100,000</b>	<b>K80,000</b>
<b>Variable costs</b>			
Costs of seeds	(10X500) = 5,000	10X1200=120,000	(10X1,000) = 10,000
Costs of fertiliser	(10 x2,400) =24,000	(10 X0) = 0	(10 x 2,000)= 20,000
<b>Gross margin/profit</b>	<b>K151,000</b>	<b>(K20,000)</b>	<b>K50,000</b>
<b>Less: Fixed costs</b>			
Depreciation	K500	K500	K500
<b>Net profit</b>	<b>K150,500</b>	<b>(K20,500)</b>	<b>K49,500</b>

The farmer should be encouraged increase the hectarage of maize enterprise since more profits will be made.

### DIFFERENCES BETWEEN COMPLETE BUDGET AND PARTIAL BUDGET

Complete Budget	Partial Budget
<ul style="list-style-type: none"> <li>The whole farm is considered as one unit</li> </ul>	<ul style="list-style-type: none"> <li>It is adopted when minor aspect of farm organisation is considered</li> </ul>
<ul style="list-style-type: none"> <li>All the aspects like crops, livestock, machinery and other assets are</li> </ul>	<ul style="list-style-type: none"> <li>It is practiced within the existing resource structure of the farm</li> </ul>

considered	
<ul style="list-style-type: none"> <li>• Both fixed and variable costs are calculated for working costs and returns</li> </ul>	<ul style="list-style-type: none"> <li>• Only variable costs are considered</li> </ul>
<ul style="list-style-type: none"> <li>• Net income is estimated by deleting/subtracting fixed costs and costs of variable inputs from the value of the product.</li> </ul>	<ul style="list-style-type: none"> <li>• Net income is estimated by deleting/subtracting only costs of variable inputs from the value of the product</li> </ul>
<ul style="list-style-type: none"> <li>• It requires more efforts and time preparation</li> </ul>	<ul style="list-style-type: none"> <li>• It requires relatively less efforts and time for preparation.</li> </ul>

### **BREAK-EVEN BUDGET**

- **Break-even point** is the point where sales revenue line meets the total cost line and the firm has managed to cover up fixed costs and variable cost.
- In other words, **Break -even point** is where  $\text{Total Revenue} = \text{Total Cost}$  where the firm makes neither profit nor loss.
- **Break- even quantity- It** is the quantity where the firm covers fixed costs and variable costs. The quantity where the  $\text{TR} = \text{TC}$

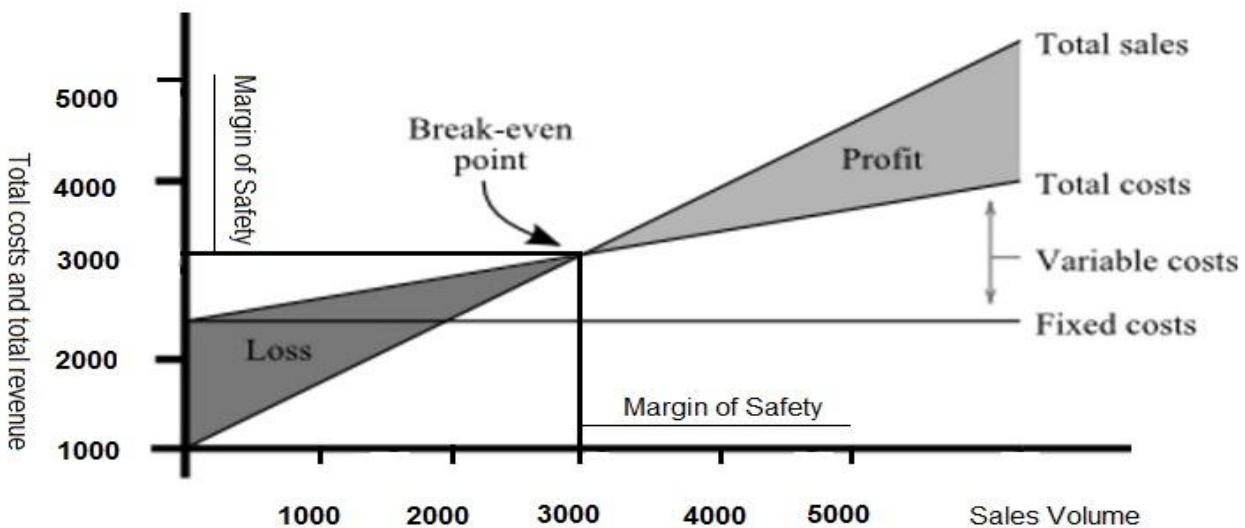
**Angle of incidence**– It is the angle that reveals the rate at which the profits increases. A larger angle indicates high rate of earnings while a smaller angle indicates a low rate of earnings.

- Margin of safety is the extent by which sales could fall before a loss is incurred.

**Margin of safety = Budgeted Total revenue- Break even point sales**

**NB** Producing any quantity less than the break even quantity the firm makes losses. Producing quantity above break-even point, the firm makes profits. The sales revenue line is also **called contributory line**.

- **Contribution-** Contribution is the difference between total revenue and total variable costs.
- In other words, **contribution** is the figure when the total variable costs/marginal costs of a number of products are deducted from the total sales revenue.
- The graph below shows the Break-Even Point where Total sales intersect with Total Costs, Break-Even Quantity (3000 units), Break-Even Value(K3,000)



**Total Cost = Fixed Costs + Variable Costs:**

$$TC = FC + VC;$$

Profit Relationships;

Profit = Revenue – Total Cost

$$P = R - TC$$

$$P = R - \{FC + VC\}..$$

### PREPARATION OF BREAK-EVEN CHART

If volume is below the BE point, the difference between the lines **represents a loss**

1. Use the horizontal axis for units of output and vertical axis for monetary values like sales, revenue and total costs.
2. As fixed costs remain the same at all output levels so the fixed costs line is drawn across the chart as a straight line parallel to the horizontal axis.

**Fixed costs** are the type of production cost that remains constant regardless of the increase in the level of business activities/output within a given period of time. Fixed cost must be incurred even if production output is zero. Examples are rental fees for lease, interest payable on loans, insurance premium

3. The variable cost line commences on the vertical axis from the same point where the fixed cost line intersects the vertical axis. This is to show total cost on the chart.

**Variable costs** are those costs in a cost function that change with respect to rate of change of the firm's output. These may include wages; agricultural inputs such as pesticides, fertilizer etc.

4. On the chart break-even point represents the point at which total cost and total revenue lines cross each other.



**Total costs-** Total costs refer to the combination of fixed costs and variable costs in a given period of time.

$$\text{Total costs} = \text{Fixed Costs} + \text{Variable Costs}$$

5. The break-even point so determined tells the reader that the break-even point in terms of units of output on the horizontal axis and in terms of sales revenue and total costs on the vertical axis.
6. Shaded area below the break-even point indicates losses where shaded area above the break-even point indicates profit.
7. Profit and loss on break-even chart may be determined by looking at the vertical distance between the sales revenue and total cost line.
8. The difference between the prevailing sales and the break-even sales represents margin of safety both in terms of sales revenue and the output level.
9. If the break-even point appears well over the right side of the chart then it would imply too high total fixed costs or low contribution. This will result in lower margin of safety.
10. If the break-even point is to the left side of the chart coupled with a large angle of incidence then it would imply either lower total fixed costs or high contribution.

### EXAMPLES

**Table 1 : Total Revenue and Total Cost and BEP**

Output in units	Total Revenue	Total Fixed Cost	Total Variable Cost	Total Cost
0	0	150	0	150
50	200	150	150	300
100	400	150	300	450
150	600	150	450	600 BEP
200	800	150	600	750
250	1000	150	750	900
300	1200	150	900	1050

(Selling Price : Rs. 4 per unit)

### TYPES OF BREAK-EVEN POINT

#### 1. Break even based on sales

This happens to value added enterprise that is selling produces, or other proceeded foods, products in large quantity.

#### 2. Break even based on units

This is the value added enterprise that sells defined units of products such as limited number of cattle, goats or sheep.

#### 3. Break even yield

This is the yield needed to cover the costs given the expected price.enterprise income and other income such as in kind payments.

**Break even yield = Total Fixed Costs/(Selling Price/unit-Variable cost/unit)**

#### 4. Breakeven price

This is the price needed to cover the costs given the expected yield and income.

**Break even yield = Total Fixed Costs/(Selling Price/unit-Variable cost/unit)/Selling price /unit x 100**

### **WHAT CAN THE FARMER DO IF IT IS NOT POSSIBLE TO BREAK EVEN WHEN EMBARK ON THE BUSINESS?**

1. He should try to reduce the fixed costs by negotiating land rental or keeping control of telephone bills or other fixed costs.

2. He should try to reduce variable costs through input substitution by adopting organic farming
3. Increasing the selling price of maize through selling maize in times of scarcity.

The aim of these three points is to reduce break even and increase profits.

### **PURPOSES OF BREAK-EVEN BUDGET**

1. It determines the minimum output that must be exceeded in order to make profit.
2. It serves as a rough indicator of earnings/income impact of marketing activity.
3. It provides a dynamic view of the relationship between sales, costs and profits.
4. It gives a manager a chance to understand when to expect to break-even by linking the percent to when in the week/month this percent sales might occur.

## **CHAPTER SIX: FARM BUSINESS DECISION MAKING**

The farmers have to make the right decisions in order to maximize profits.

### **Examples of farm decisions made by farmers include**

1. What to produce
2. How to produce
3. How much to produce
4. When to produce
5. Where to buy and sell.

## **ECONOMIC PRINCIPLES IN FARM BUSINESS DECISION-MAKING**

### **1. OPPORTUNITY COST**

- Opportunity cost is defined as the value of forgone alternative. It states that when a farmer decides to produce cassava instead of yams, the difference in value between yams and maize is forgone alternative and therefore an opportunity cost.
- It is also defined as the next best reward that has not been earned because a farmer has decided to engage in another enterprise.
- Opportunity cost help farmers to select enterprises with lower opportunity cost which enable them to benefit more.

- Below is an illustration:

Farmer	Enterprise	Revenue (K)
A	Maize production	150
B	Chicken production	200

- ✓ In the table above, farmer **A** decides to engage in maize production whose revenue is K150. On other hand, farmer **B** has decided to raise chickens and earn revenue of K200.
- ✓ The opportunity cost of farmer A is the K200 from chicken production while that of farmer B is the K150 from maize production.
- ✓ As a guiding principle, farmers should engage in those enterprises whose opportunity cost is lower. In the example given above, the farmer would be encouraged to engage in chicken production.

## 2. COMPARATIVE ADVANTAGE

- This is the principle that states that farmers should engage in those enterprises that they can best produce in their areas using the resources at their disposal.
- This principle also states that the farmers must concentrate and take advantage of enterprise which best suit the environmental conditions of their area.
- These resources include climatic conditions, soil factors and managerial skills among others,
- For example, farmers in Tsangano area in Ntcheu have comparative advantage over the farmers in hot areas of Malawi in the production of Irish potatoes.

**Example**

Place	Yield in kg	
	Maize	Beans
Lilongwe	2,200	2,000
Dedza	1,900	3,000

In the table above, the farmers in Lilongwe and Dedza both grow maize and beans. According to the law of comparative advantage, farmers' in Lilongwe would be encouraged to concentrate on growing maize while those in Dedza would be encouraged to grow more beans.

The principle of comparative advantage encourages farmers to specialize which promotes efficient production.

### **ADVANTAGE OF THE PRINCIPLE OF COMPARATIVE ADVANTAGE**

- It encourages farmers in each area to select at least one product that suited their area and concentrate on and offer it to the market, trading nationally or internationally.

### **3. SUBSTITUTION OF INPUT**

- The principle of substitution states that it is beneficial for a farmer to substitute an input , resources , technology for another if it reduces costs but produces the same level of yield or has the same cost but increases yield.
- The principle of input substitution encourages farmers to select a combination of inputs that produce the desired output at the lowest cost produce.
- It states that the farmer should continue adding an input so long as the cost of the inputs being replaced is less than the saving in cost of the input being replaced.
- **Examples of input substitution are**
  - a. Weeding by a hoeing out the weeds or spraying herbicides.
  - b. Feeding layers on a commercial ration or a home mix.
  - c. Chemical fertilizers can be replaced with organic manure.

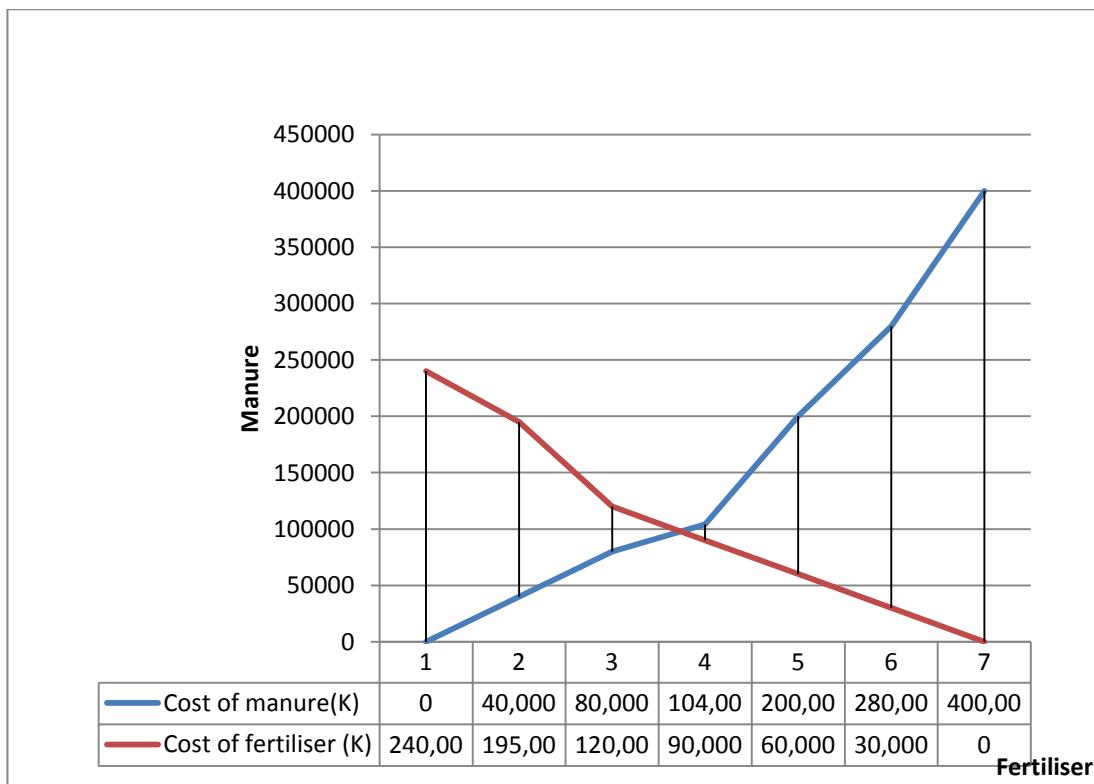
### **EXAMPLE**

To produce 200 bags of maize, a farmer has a choice of either using manure or fertiliser or a combination of both. The cost of manure is K800/bag while that of fertiliser is K15, 000/bag. The table below summarizes the different combinations of manure and fertiliser that would yield 200 bags of maize.

**Input substitution table**

Output (maize bags)	Bags of manure	Bags of fertiliser	Cost of manure(K)	Cost of fertiliser (K)	Total Cost (K)
200	0	16	0	240,000	240,000
200	5	13	40,000	195,000	235,000
200	10	8	80,000	120,000	200,000
200	13	6	104,000	90,000	194,000
200	25	4	200,000	60,000	260,000
200	35	2	280,000	30,000	310,000
200	50	0	400,000	0	400,000

- From the table, if the farmer decides to use **fertiliser only**, there will be to apply **16 bags** whose cost is **K240, 000**. If the decision is to **only use organic manure**, a total of **50 bags** will be required whose cost is **K400, 000**. All these decisions will be **unwise**.
- The least cost combination is obtained when **13 bags of organic manure and 6 bags of inorganic fertilizers** are used. The cost of this combination is K194,000. It would be wise for the farmer to adopt this combination of inputs.



The least combination is where cost of manure curve and cost of fertiliser intersects **at (1004, 000 + 90,000 = K194, 000)**. As noted from the graph, the least cost combination point is the point on which the line graph is closest to the origin of the graph.

### **IMPORTANCE OF THE PRINCIPLE OF SUBSTITUTION OF INPUTS**

1. It guides the farmer in choosing the cheaper or profitable inputs, resources or technology of production.
2. It helps the farmer to answer the farm management question on how to produce.

### **4. DIMINISHING MARGINAL RETURNS**

- The law of **diminishing marginal returns** states that an increase in one input with everything remaining constant, will increase output but after a point , the extra output resulting from the additional inputs will become less.
- In the definition, **Diminishing means** delining or getting reduced, **Marginal means** additional or incremental and **Return means** output or yield.
- The law is clearly advising the farmers to decide on the right amount of inputs for every enterprise because too much inputs is dangerous.

### **THE STAGES OF THE LAW OF DIMINISHING MARGINAL RETURNS**

#### **1. STAGE OF INCREASING MARGINAL RETURNS**

- In this stage, the additional input causes the marginal output rises. In this level output is performing wonderfully due to availability of other productive resources. In the graph below, it is region A.
- However, production within this zone will not be a wise decision because the inputs are not being adequately used. This leads to less profitability.

#### **2. STAGE OF DIMINISHING MARGINAL RETURNS**

- In this stage, the additional input causes the marginal output to lessen because of competition between production resources resulting in reduction of the marginal yield. In the graph below, it is shown by the region B.

- This is the zone in the graph where the graph is at its peak, meaning that the resources are being put to good use.

### **3. STAGE OF NEGATIVE RETURNS**

- This is the stage when the additional output becomes too excessive compared to fixed resources causing the marginal output to be negative.
- In this zone, the graph has started to decline. This means that additional bags of fertiliser for example, will result into a reduction in the number of maize bags harvested. Producing anywhere within this zone will not be a wise decision because it will result into more losses.

#### **EXAMPLE OF AN ILLUSTRATION OF THE LAW OF DIMINISHING MARGINAL RETURNS**

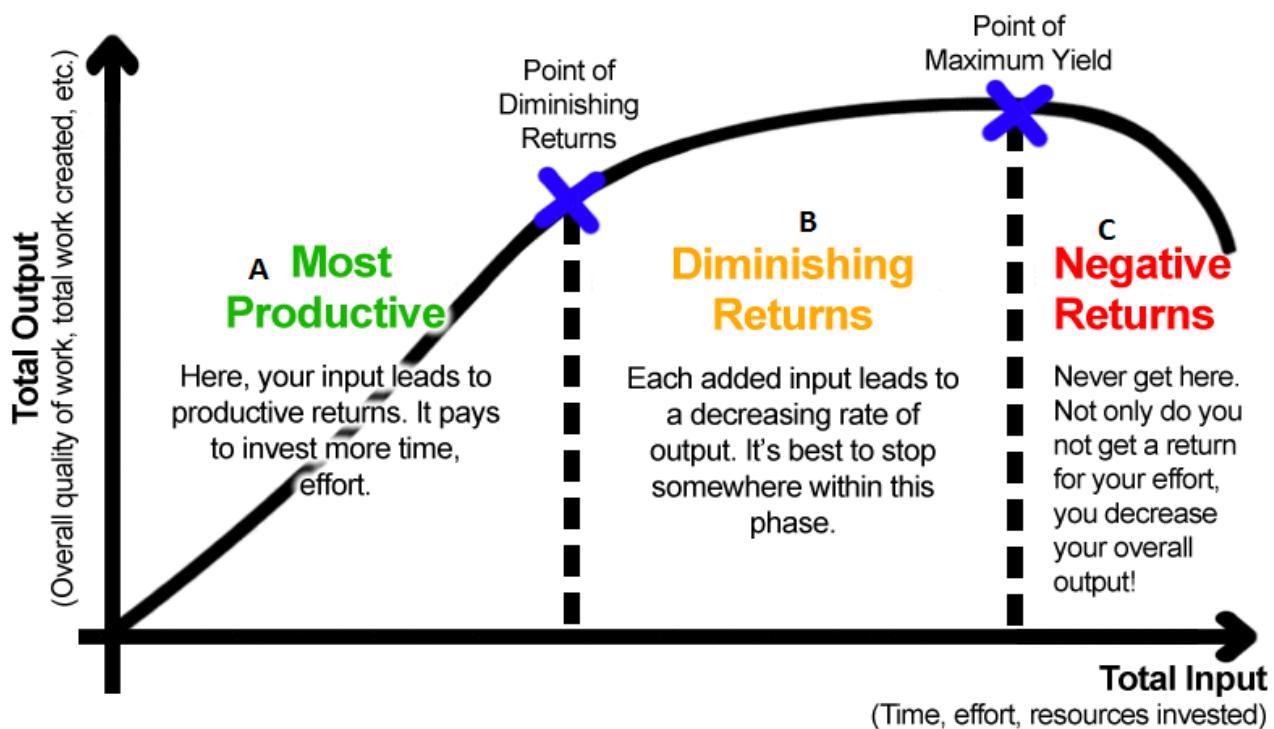
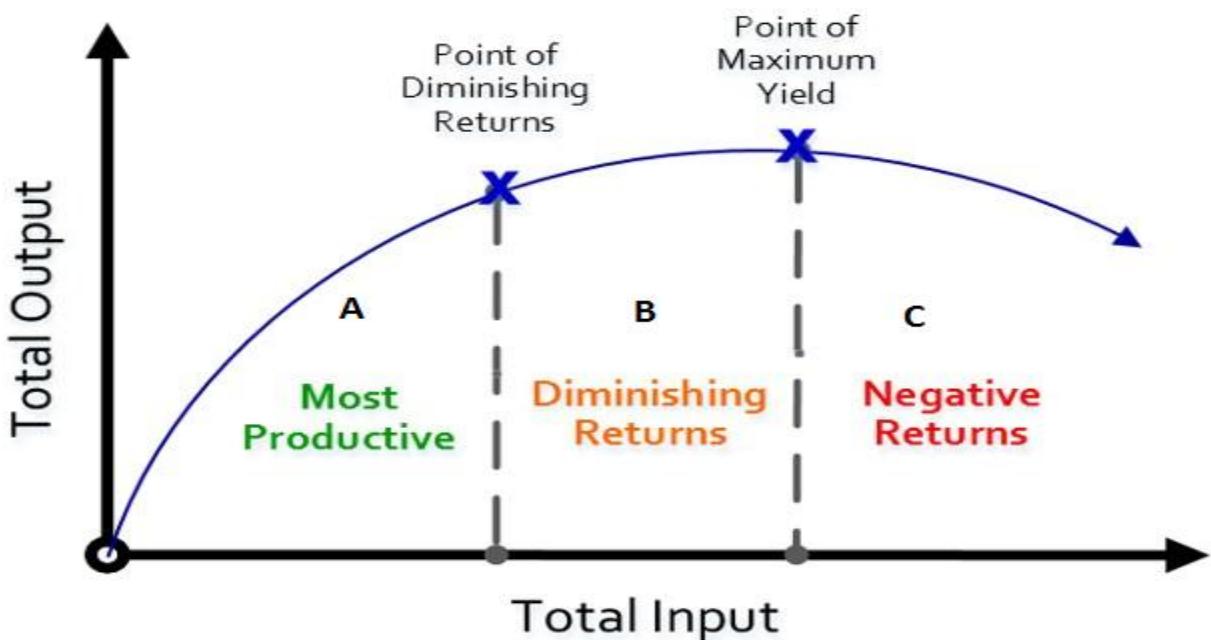
- The table below shows the number of workers and the output achieved. Use it to calculate the average product and marginal returns. Citing stage of marginal returns.

Labour	Total output
1	8
2	24
3	54
4	82
5	95
6	100
7	100
8	96

#### **AVERAGE PRODUCT & MARGINAL RETURNS & SHOWING STAGE OF MARGINAL RETURNS**

Labour	Total output	Average product	Marginal returns	Stage of marginal returns
1	8	8	8	Increasing Marginal Returns
2	24	12	16	
3	54	18	30	
4	82	20.	28	Diminishing Marginal Returns
		5		
5	95	19	13	
6	100	16.	5	
7	100	14.	0	
8	96	12	-4	Negative Marginal Returns

## THE GRAPH SHOWING LAW OF DIMINISHING MARGINAL RETURNS



## **IMPORTANCE OF THE PRINCIPLE OF DIMINISHING MARGINAL RETURNS IN DECISION-MAKING**

1. It helps the farmer to understand the relationship between level of inputs and production so that the farmer can decide on the best level of inputs to use for optimum production.
2. It helps the farmer to identify the stage when diminishing returns set-in.
3. It helps the farmer to deal with increasing marginal costs that would otherwise arise from increasing levels of inputs.
4. It helps the farmer to avoid waste of farming resources that would even result in negative returns.
5. It helps the farmer to understand that there is a stage where benefits of doing something will slowly diminish.
6. It helps the farmer to understand that spending and investing more in a product where other factors remain the same mean that the returns will eventually begin to diminish in long run.

## **CHAPTER SEVEN: ENTERPRISE COMBINATIONS**

- A farm enterprise is a single type of crop or livestock that produces a marketable products or commodity.

### **EXAMPLES OF FARM ENTERPRISE IN MALAWI**

These include

1. Goat farming
2. Broiler production
3. Sheep production
4. Dairy farming
5. Maize production
6. Groundnut farming
7. Cabbage farming

8. Cassava farming
9. Tobacco farming

#### **EXAMPLES OF COMBINATION THAT CAN BE MADE BY THE FARMER ON THE FARM**

Examples of the combination of two or more farm enterprises that can be made by the farmer include

1. Crop enterprises only
2. Livestock enterprises only
3. Crop and livestock enterprises

The enterprises can be combined because of their capacity to benefit each other or benefit the farmer.

#### **FACTORS THAT CAN BE CONSIDERED WHEN COMBINING ENTERPRISES**

##### **1. Profitability of an enterprises**

Farmers choose enterprises whose total can be significantly.

##### **2. The farmers' food requirements**

Farmers produce food for consumption and before they venture into cash crops farmers have to ensure that they have enough food in stock.

##### **3. Resource availability**

###### **a. Land**

- Land determines the type of enterprise to venture into and how many enterprises to combine due to the nature of the soil (slope and type of soil).

###### **b. Labour-Labour**

- Labour is the amount of work done by human and this limits the size of enterprise due to increase in labour in labour demand for some months on some crops.
- Farmers make labour profiles which show how labour is distributed during production period.
- Labour is estimated in man-days. Adult male supplies 25 man days per month, adult female supplies 16.7 man days. Adult male supplies 25 man days per month, while child supplies 7.5 man days.

###### **c. Capital**

- Capital refers to both live and dead stock on the farm used for production and the money needed to run the farm. It is always scarce so farmers have to use it economically.

**d. Management**

Management is defined as the inherent skills the farmers has in decision making and farmers have to make sound decisions on what most economical enterprises to combine and how well resources can be put into use.

**4. Nature of enterprises.**

The three types of nature enterprise

**a. Competitive enterprise**

- These are enterprises which compete for scarce resources like labour, land and capital.
- They are those enterprises in which an increase in output of one enterprise causes a reduction in the output of the other enterprise.

**Example:**

- ✓ Maize and Forestry - When the farmer combines maize and forestry on the same amount of land, an increase in maize production will lead to reduction of land for forestry.
- ✓ Tobacco farming and maize farming
- ✓ Dairy production and beef production
- ✓ Layers production and broiler production

**b. Supplementary enterprise**

- This is an enterprise combination in which one enterprise is the main enterprise while the other the additional one. In this enterprise combination, one enterprise benefits the other enterprise on the land.
- In this enterprise combination, the farmer does not reduce the size of maize enterprise in order to expand the bean enterprise.

Two products are said to be supplementary when an increase in the level of one does not adversely affect the production of the other but adds to the income of the farm

i.e enterprise which do not compete with each other but adds to the total income.

For example, on many small farms daily enterprise or a poultry enterprise may be supplementary to the main crop enterprises because they utilize surplus family labour and shelter available and perhaps even some feeds, which would otherwise go to waste.

### c. Complementary enterprise

➤Complementary enterprises are those, which add to the production of each other.

e.g. Berseem and maize crops.

➤Two products are complementary when the transfer of available input for the production of the one product to the production of the other results in increases in the production of both products.

➤Then two crops are complementary enterprises, the use of resources for the two crops result in the increases production on both the crops.

- They are combined to assist one another.

#### Examples

##### a. Maize and climbing beans

The beans supports maize with nitrogen which it fixes while maize provides beans with support.

##### b. Duck and fish in the fish pond

Ducks provide manure to the pond while fish can be fed to the ducks.

### 5. Opportunity cost

Farmers are more likely to engage in enterprise whose opportunity cost is lower.

### 6. Comparative advantage

This encourages farmers to specialize and concentrate in producing those commodities that do better in their respective areas. This may therefore restrict farmers from having several enterprises on their farms.

**7. Government policies**

Some government policies may prohibit the production of certain commodities in a country. For this reason, farmers may not be able to engage in those prohibited enterprises despite having enough resources to produce the commodity.

**8. Risks and uncertainties**

Farmers are encouraged to choose those enterprises whose level of risks is low.

**9. Availability of markets**

Farmers need to make sure that there is a ready market for the agricultural commodity they want to produce

**WAYS OF SAFEGUARDING AGAINST RISKS AND UNCERTAINTY****1. Diversification**

This involves undertaking different enterprises with the hope that not all will fail.

**2. Purchasing of insurance cover**

This will be important because when the enterprises fail beyond farmer's control, the insurance company can compensate.

**3. Input substitution**

The farmer should not invest a lot into an expensive input but should rather replace the expensive one's with less expensive one. For example, replacing inorganic fertilizer with organic manure to reduce production costs.

**4. Flexibility in the methods of production**

Farmers should be advised to use capital items which can easily be returned for different enterprises.

**5. Farmer's ability**

The farmer must choose the enterprise in which he/she must have the skills in managing it.

## **CHAPTER EIGHT: AGRICULTURAL COOPERATIVES**

**Agricultural cooperatives** are defined as a group of farmers who come together on voluntary basis for the purpose of achieving a common goal for mutual economic benefit.

### **IMPORTANCE OF AGRICULTURAL COOPERATIVES**

1. They produce or markets goods cheaply because they share the resources and expertise.
2. They secure loan from the commercial banks because a group serves as a security.
3. They buy inputs cheaply since they buy in bulk and at wholesale price.
4. They benefit from the economies of scale. It is cheaper to produce a unit of commodity if it is mass produced.
5. They easily transport produce to the market.
6. They easily bargain for better prices or selling conditions as a group.
7. They share storage and processing facilities.
8. They quickly adopt innovation by sharing expertise and knowledge.

### **PRINCIPLES FOR THE FORMATION OF AGRICULTURAL COOPERATIVES**

1. They should be legally constituted with guiding rules and regulations.
2. Participation in cooperation cooperatives is free, people are free to join or withdraw.
3. They should be impartial, non-partisan and non-religious.
4. They must be open to all farmers who share a common interest.
5. They should have enough capital/funds for their operations.
6. They should be organized and run according to democratic principles basing on one person, one vote.
7. They must continually educate their members to improve their productivity and marketing skills.
8. All members should be committed to the cooperatives and its success.

9. They should have adequate infrastructures such as staff houses, offices, and storage facilities, personnel, transport, equipment and supplies.
  10. They should join from the local to the national level
  11. Members managing funds should be skilled, trustworthy and highly motivated
  12. They should follow legal procedures of forming and registering a cooperative.
- Examples of the legal procedures to be followed when forming and registering agricultural cooperatives include:
- a. They should have minimum number of ten eligible persons
  - b. They should elect an interim committee
  - c. They should draft the cooperative's constitution.
  - d. Articulate the objectives of the cooperatives
  - e. They should suggest a name for the cooperative.
  - f. They should apply for registration to the relevant agricultural authorities.

### **TYPES OF FARMERS' AGRICULTURAL COOPERATIVES**

These include

1. Farm production cooperatives
2. Marketing cooperatives
3. Consumer cooperatives
4. Savings and credit cooperatives (SACCO)

### **FACTORS THAT AFFECT THE SUCCESS OF AGRICULTURAL COOPERATIVES**

#### **a. Sufficient capital base**

Having enough capital is very important for the smooth running of a cooperative society.

#### **b. Clear goals and objectives**

They define the direction in which the cooperative should be run.

#### **c. Professionalism**

People entrusted with running the affairs of agricultural cooperative should be well qualified and competent in their respective fields such as legal, accounting, auditing marketing etc that may be required.

**d. Education and training**

This helps the members to be equipped with relevant skills and expertise for the smooth running of the cooperative.

**LIMITATIONS/CHALLENGES OF RUNNING AGRICULTURAL COOPERATIVES****1. Lack of loyalty to the cooperatives**

This occurs when members fail to abide by their own rules and regulations on issues of repayment of loans. This brings quarrels and divisions within the cooperatives.

**2. Misuse of fund by executive members**

This is a serious issue because members of the executive need to be trustworthy.

**3. Lack of sound economic base of the cooperative**

This makes it impossible for members to obtain loans and other benefits.

**4. Lack of knowledge about the rights and obligation of members**

The members got frustrated when they don't get what they think are their entitlements.

**SOLUTIONS TO THE CHALLENGES FACED IN RUNNING AGRICULTURAL COOPERATIVES****1. Lack of loyalty to the cooperative**

This can be solved through advocacy where members should believe that the cooperative is their own and they cannot afford to see it fails since its failure is their failure.

**2. Misuse of funds by executive members**

This can be checked through putting in place mechanisms of transparency. Members should be able to monitor what is going on in their cooperative.

**3. Lack of sound economic base by the members**

This can be solved by ensuring that members meet their subscriptions and high financial prudence by executive.

**4. Lack of knowledge about rights and obligations of the members.**

This can be solved through orientation on their right and their roles.

## **CHAPTER 9: VEGETATIVE PLANTING MATERIALS**

### **Propagation**

Cereals and legumes are propagated through seeds (sexual propagation, usually from two different parents). Seed is the commonest way of propagating both self-pollinated and cross pollinated crops.

#### **Advantages of sexual propagation**

- Seeds are relatively cheap
- Seed is easy to sow and prepare for planting.
- Seed is easy to store without significant loss in quality and quantity.
- Seeds can remain viable for long periods especially when stored in a cool dry place for sowing in the next planting season
- Seed can easily be sown mechanically using seed hoppers or drills.
- Seed as a planting material minimises the risk of transmitting diseases from parents to offsprings.
- Seeds offer the only way of propagating some crops that cannot be propagate vegetatively such as maize.
- Seeds produce plants that differ from their parents (as a result of the union of male gamete and female gamete from different parents) so that some of the new plants are better than the parents leading to crop improvement.
- It provides a natural mechanism by which the characteristics of two different parents can be combined.

#### **Disadvantages of sexual propagation**

- It can produce serious variations and off-types among the offsprings (new plants since no two gametes may be alike).
- It requires a long juvenile period before bearing fruits or seeds.
- It requires elaborate seed bed (land) preparation for sowing the seed.

Cassava, bananas, sugarcane are propagated by using plant parts (e.g. stems, leaves, branches, roots, tubers) and not by seeds. This is known as asexual propagation or vegetative propagation.

### **Advantages of asexual propagation**

- Reduces the juvenile period of the plant because vegetatively produced materials assume the age of their parents faster. Plants therefore mature earlier or start bearing fruits, or producing crop yield, faster than in sexual propagation.
- Eliminates the problems of dormancy, which is a common problem in some seed treatment (such as scarification) in order for them to germinate.
- Ensures genetic uniformity in crops, which in turn affects their appearance, since all off springs will resemble their parents.
- Is the only way of propagating crops whose seeds are not viable.
- Vegetative organs are harder than seedlings from seeds. So they are better off in withstanding environmental hazards in the field, such as drought.
- Vegetative planting materials are readily available to the farmer, from the previous crop, eliminating the need to buy expensive seed each season.

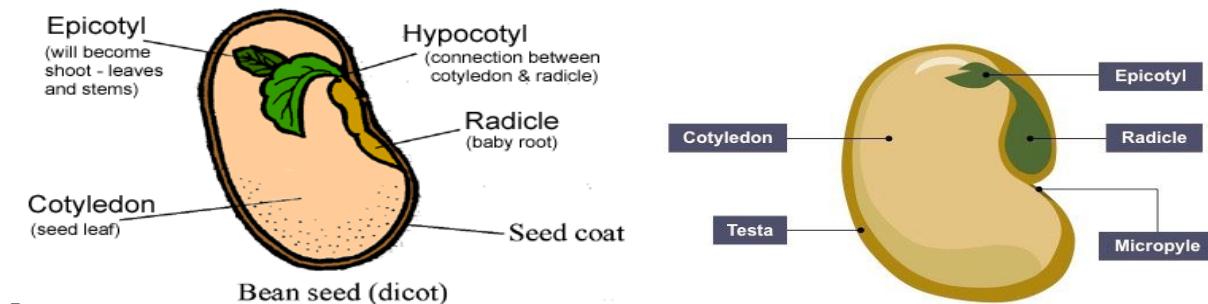
### **Disadvantages of asexual propagation**

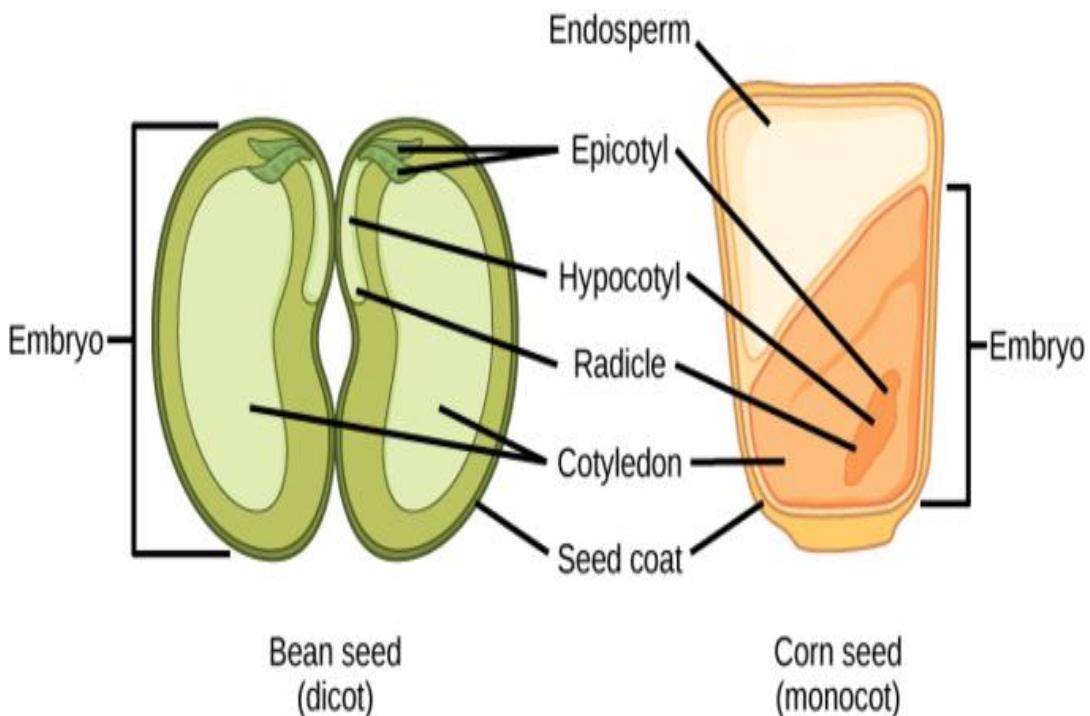
- The risk of transferring diseases to new plants is high.
- It is more difficult to introduce variation into the crop, making crop improvements difficult.
- Some of the procedures in vegetative propagation (like layering, grafting, or budding require specialist knowledge and / or skill and are slow and tedious.

## **VEGETATIVE PROPAGATION/ASEXUAL REPRODUCTION**

Vegetative propagation is defined as the production of new plants by using parts or part of an existing plant without the use of seeds.

### **PARTS OF THE SEEDS**





Bean seed  
(dicot)

Corn seed  
(monocot)

#### PARTS OF THE MAIZE GRAIN

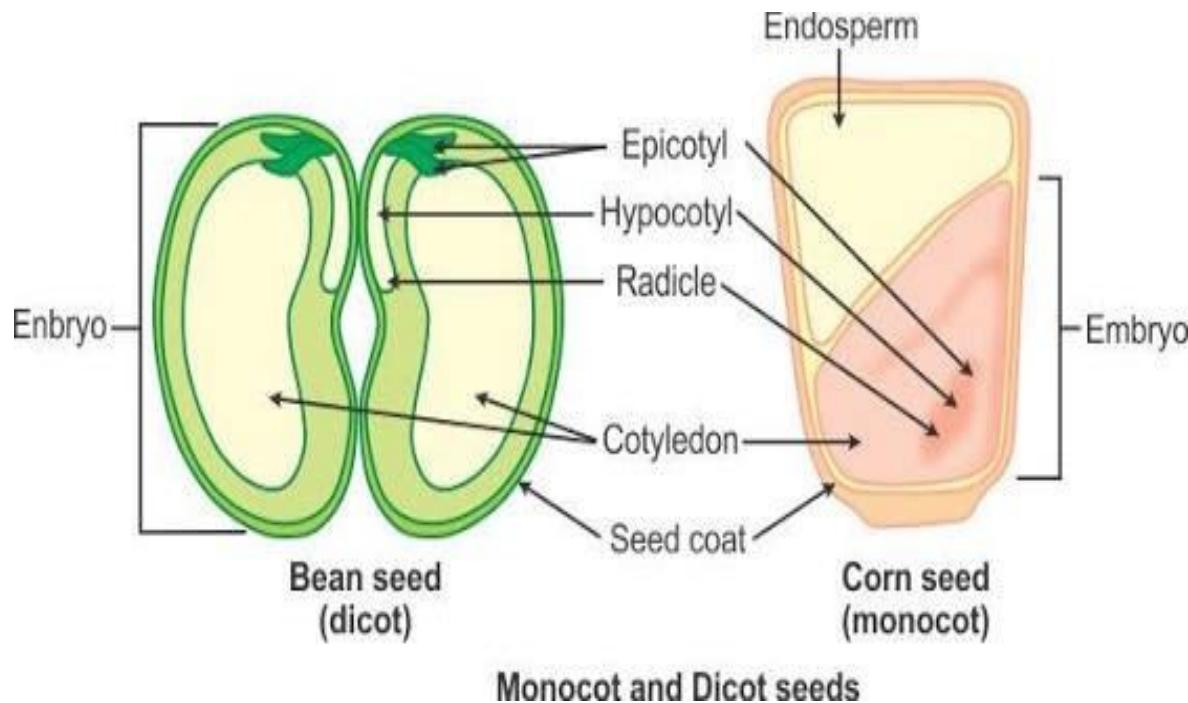
PART	DESCRIPTION
Aleurone	Protein layer
Radicle	Young shoot
Coleoptile	A sheet covering plumule in the grain.
Scutellum	A flat fleshy shield outside the embryo
Coleorhiza	A sheath covering the radicle
Silk scar	A depressed point showing a point of attachment of silk (style) to the grain (ovule).

#### FUNCTIONS OF PARTS OF A BEAN SEED

PART	FUNCTION
Funicle	It is a stalk, which attaches the bean seed to the inside of the pod.
Testa	It is a seed coat, which protects the inner parts of the seed from physical damage and disease causing organisms.
Micropyle	This tiny hole allows air to enter, for the embryo to respire. It also allows water to enter for germination process.

<b>Cotyledon</b>	It contains food for the developing embryo.
<b>Plumule</b>	It is part of embryo, which grows into shoot (leaves, branches).
<b>Hypocotyl</b>	Embryonic structure, which grows into a stem.

### FUNCTIONS OF PARTS OF A MAIZE GRAIN

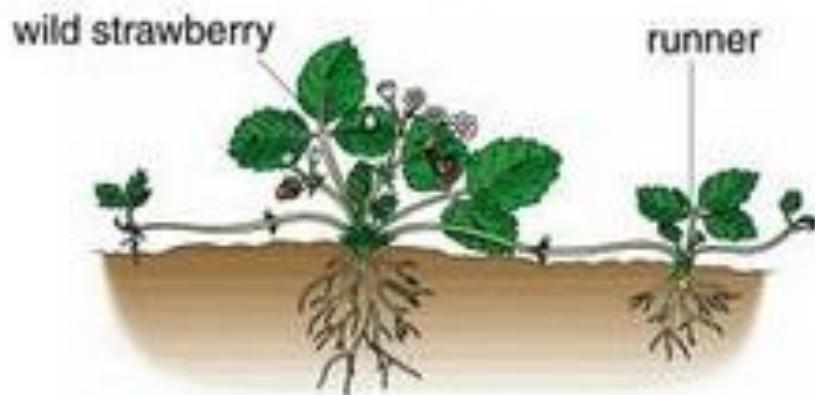


**Monocot and Dicot seeds**

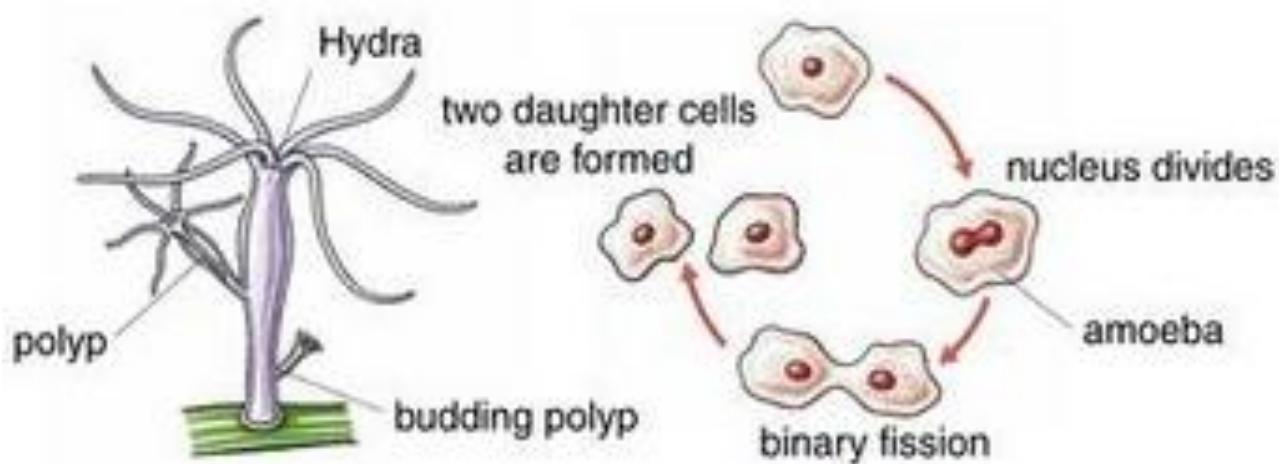
PART	FUNCTION
Fused pericarp and testa	It is called bran after milling the grain. It protects the inner parts of the seed.
Point of attachment to cob	It is a remaining part of the stalk which attaches grain to cob.
Endosperm	It is a starchy part of the grain. It provides energy for germination and growth of the embryo.
Radicle	Grows into roots.
Hypocotyl	Grows into the stem.
Plumule	Develops into first leaves.
<b>Coleorhiza</b>	This sheath protects the young roots from physical damage as they go through the soil at germination.

VEGAEATIVE PROPAGATION METHODS

Asexual reproduction

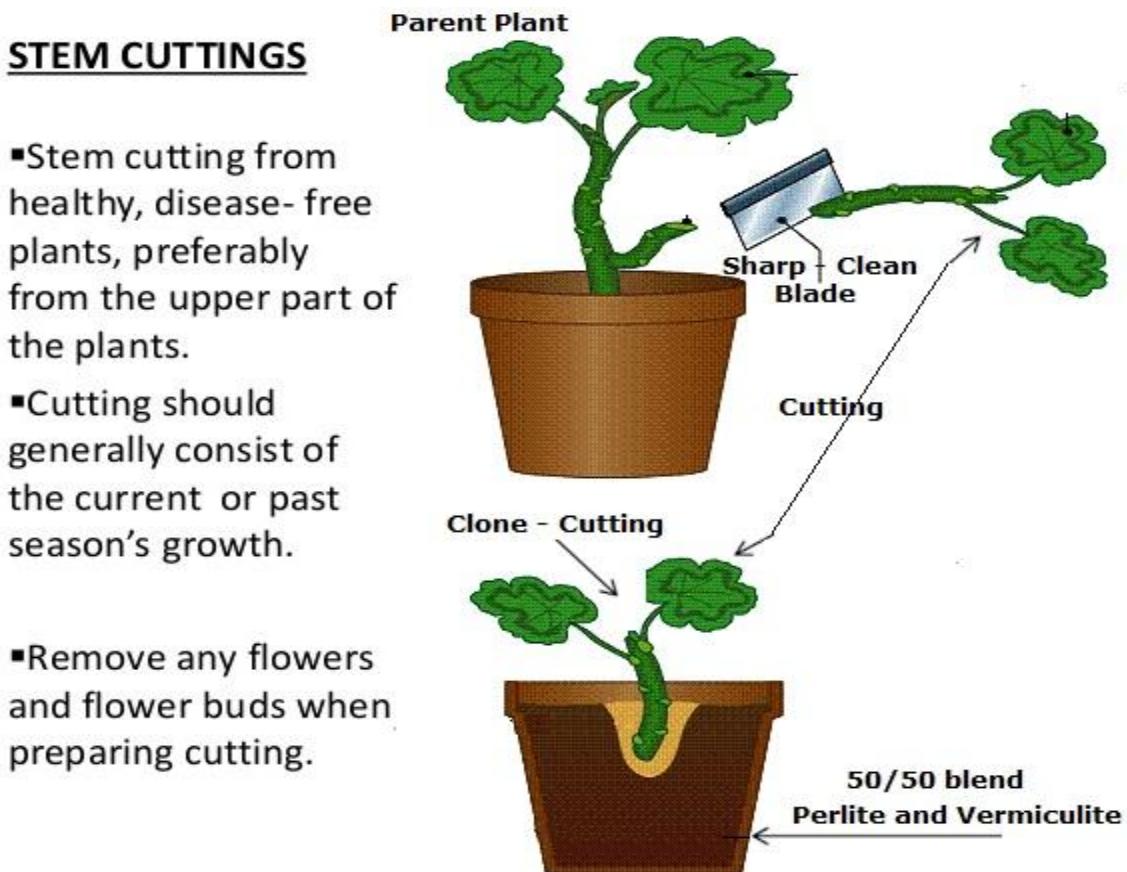


**ASEXUAL PROPAGATION**



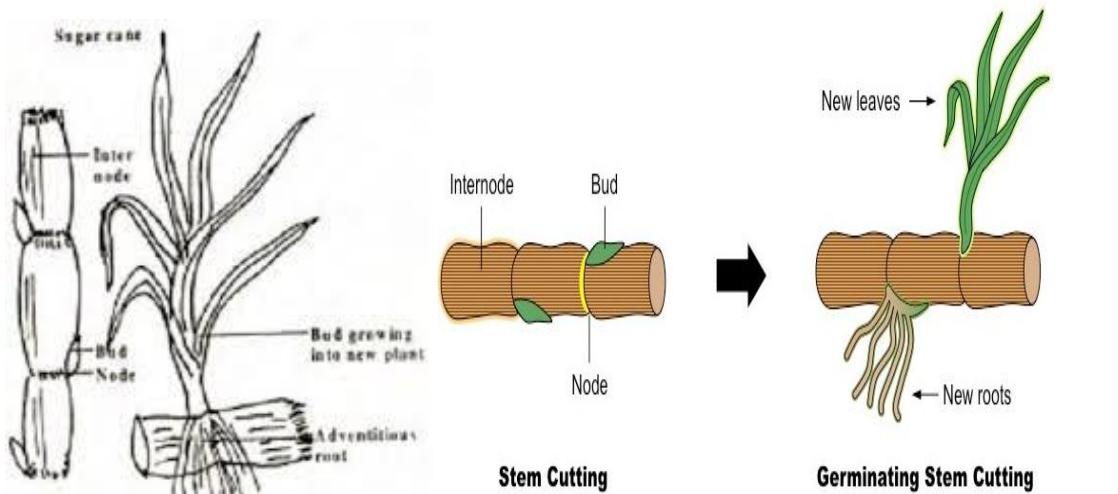
## 1. STEM CUTTINGS

Stem cuttings are pieces of stem that have buds at each node and that developed adventitious roots which are used for field planting.



Examples of plants that are propagated by stems include

### a. Sugarcane



- b. Napier/elephant grass/nsenjere
- c. Cassava

### **PROCEDURES**

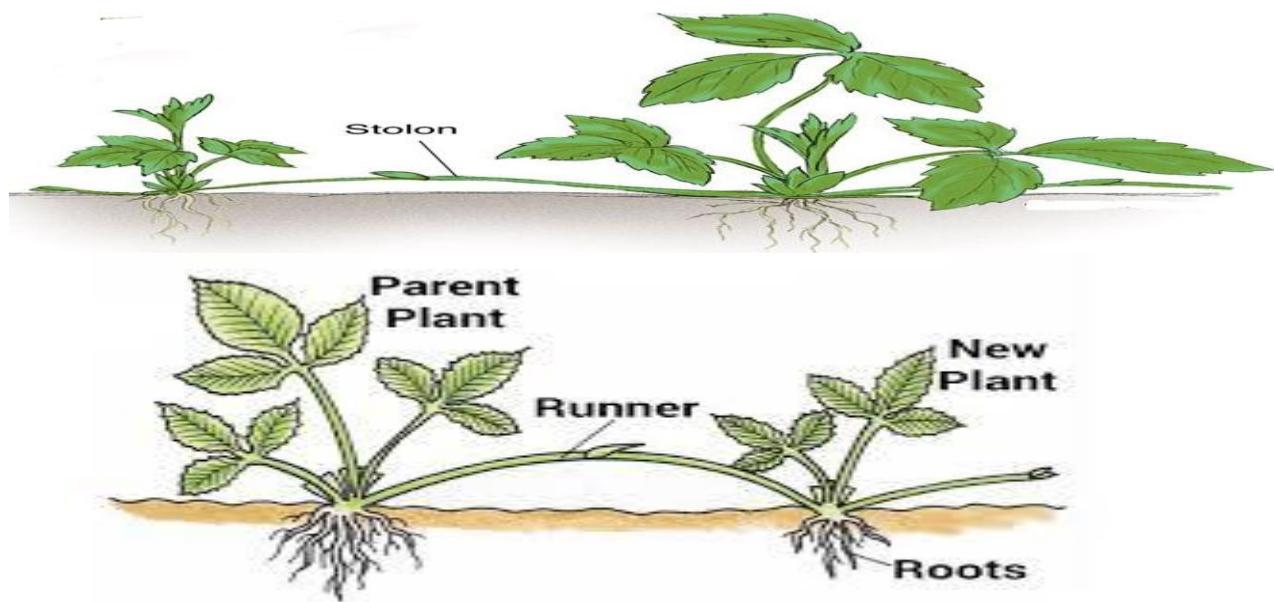
- Select the freshest uppermost parts
- Cut them into length of about 15-30cm using panga knife.
- Each stem should have three nodes since they have higher germination percentage than those having more or less nodes.

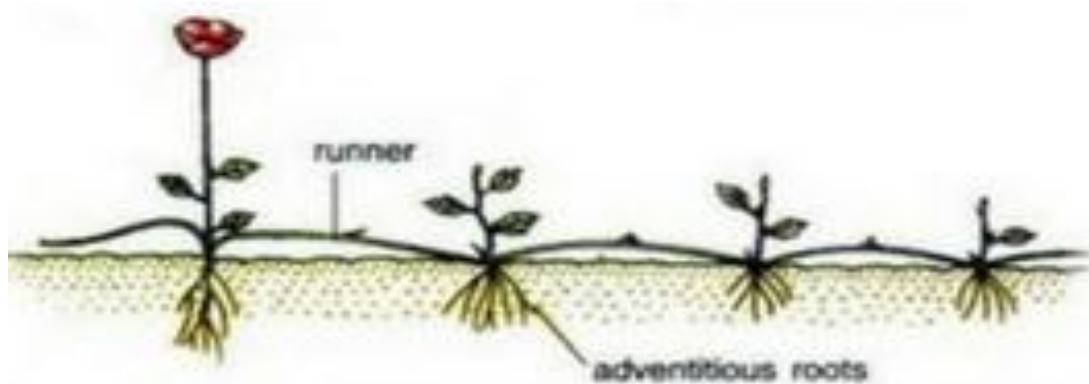
Importance of using three-node cuttings than single-node cutting

- a. To obtain high germination capacity
- b. High initial plant vigour of the germinated shoots
- c. High sugar yield

### **2. RUNNER**

- A runner is the stem which grows horizontally above the ground. The farmers cut the stems into pieces. The runner stem must have the nodes from which roots and shoots develop. The buds grow into a new plant.
- Crops such as strawberries, sweet potatoes and pastures such as Henderson star grass can be propagated by use of runners.
- The diagram below shows example of runner.

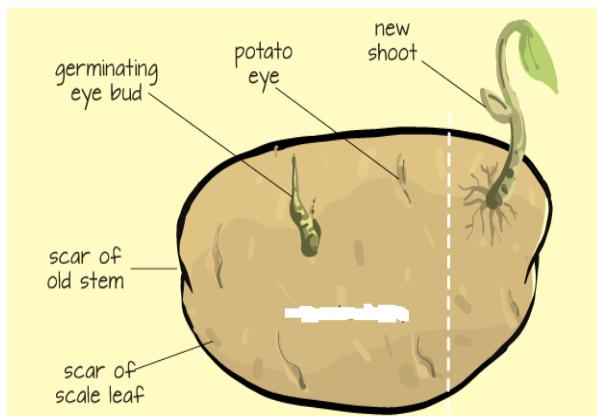




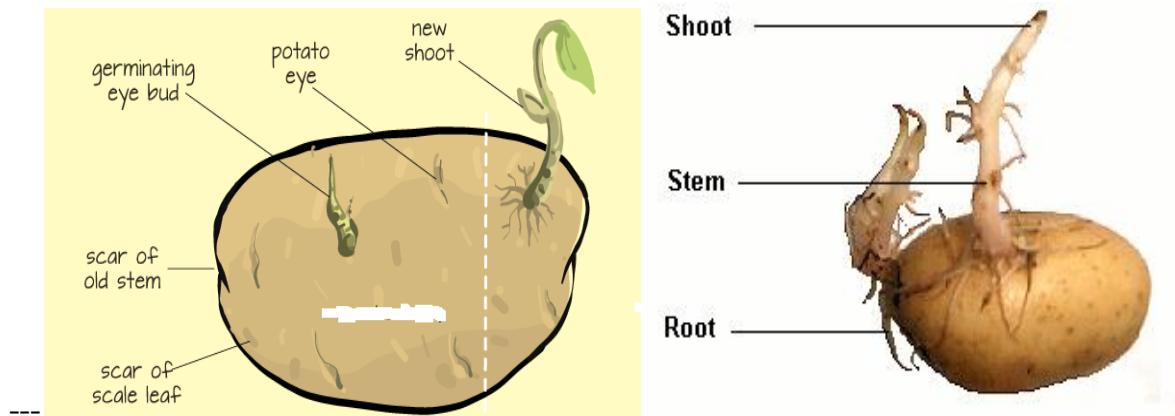
**Vegetative propagation by runner in strawberry**

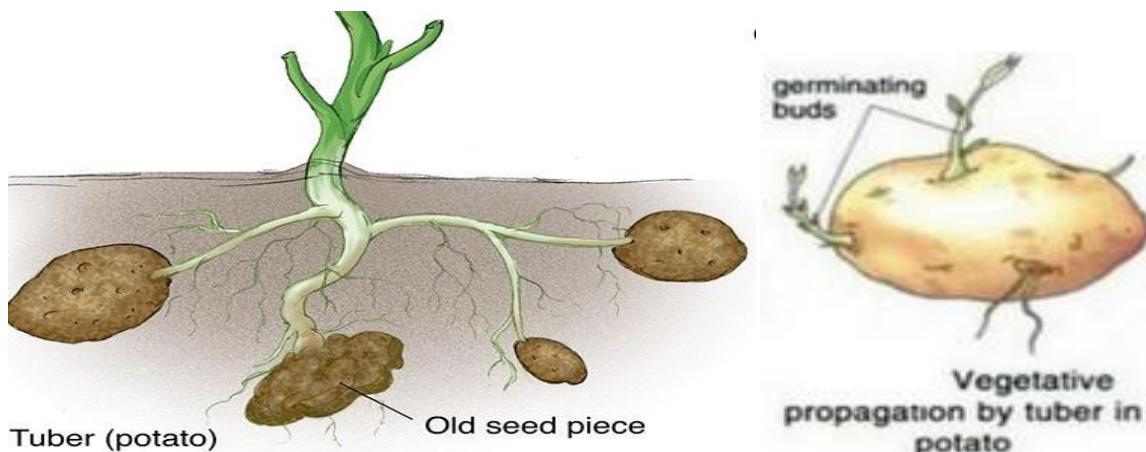
### 3. STEM TUBERS

These are underground swollen portion of the stems. The tubers act as food storage organs. The stem tubers have buds which grow into shoot and roots.

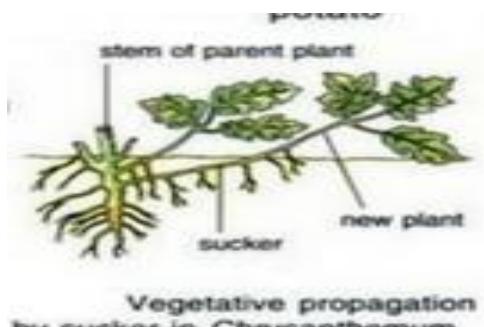


Examples of crops which are propagated using stem tubers are Irish potatoes. The diagrams below shows stem tubers.





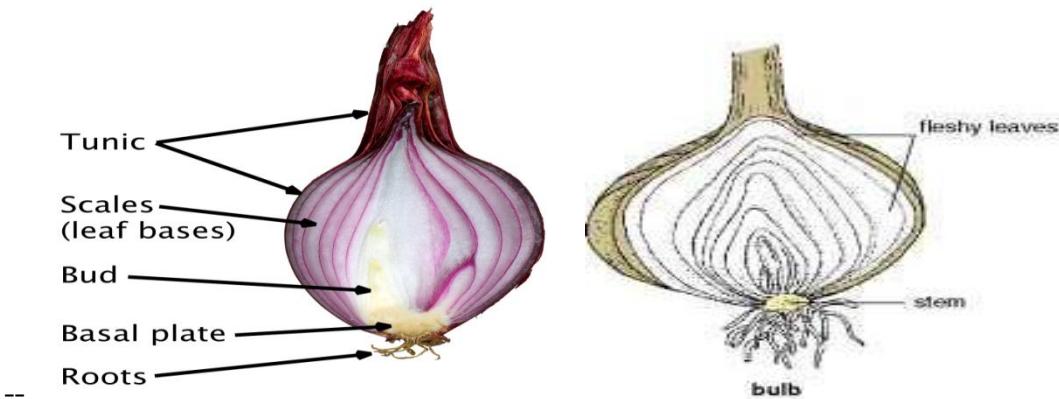
#### 4. SUCKERS

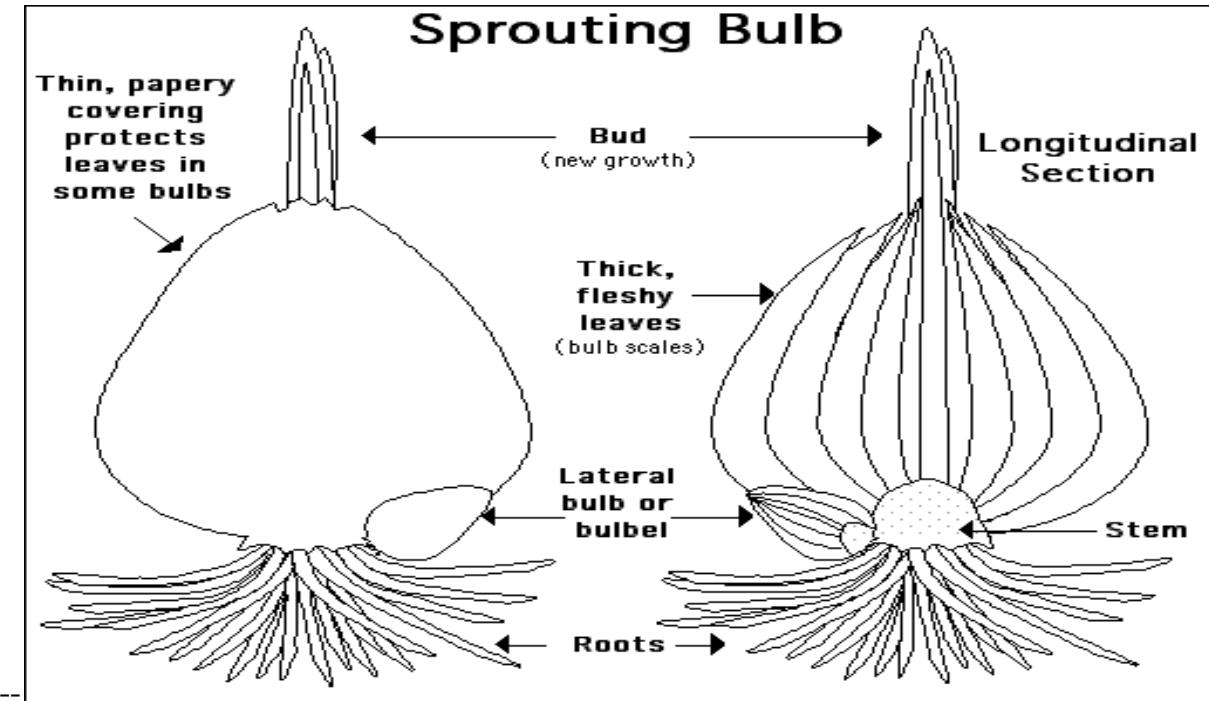
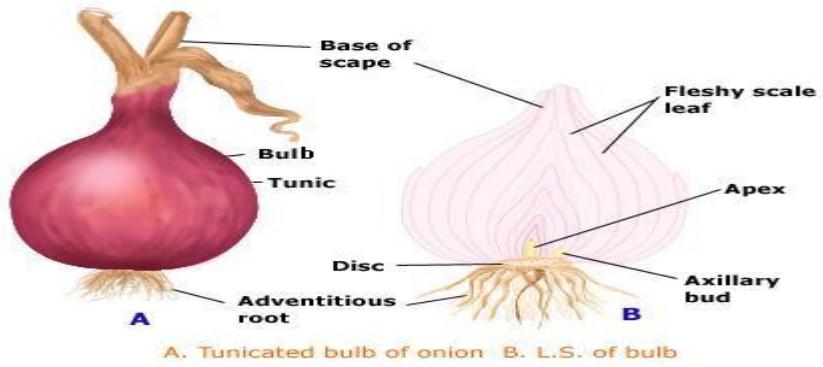


- A sucker is defined as a shoot arising from an auxiliary bud at the base of a parent plant. Suckers are cut off or uprooted and planted elsewhere.
- Example of crops propagated by the use of suckers is banana suckers.

#### 5. BULBS

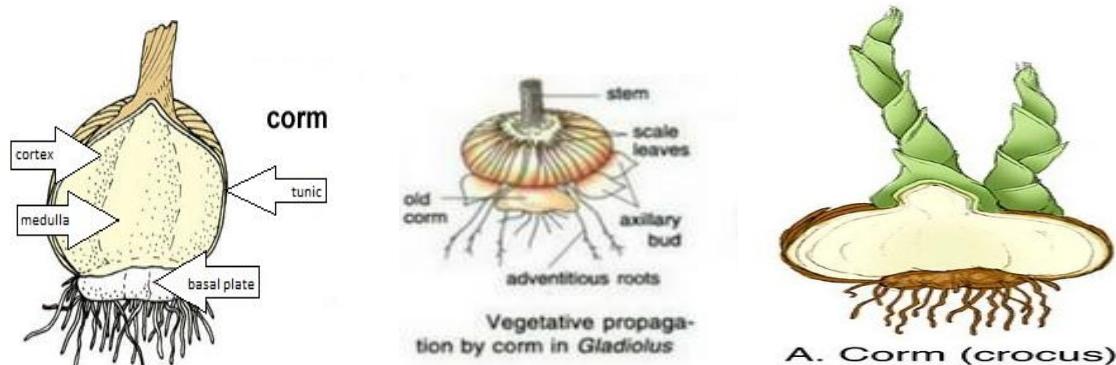
- A bulb is defined as the storage organ of vegetative planting material for crops such as onions, tulips, lilies and garlic. The leaves contain lots of stored food
- The diagram below shows bulbs of onions and tulips used for propagation





## 6. CORMS

A corm is a thickened base of underground stem in which food is stored. Shoots develop from buds which are present on the corm. The diagram below shows propagative materials used by farmers on the farmers.

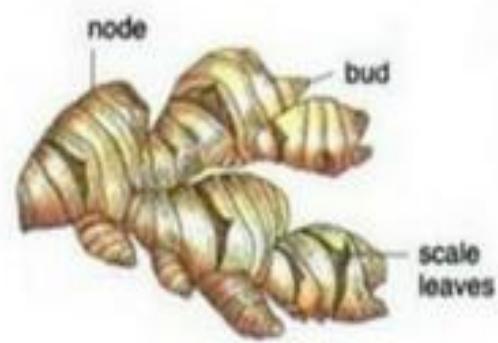
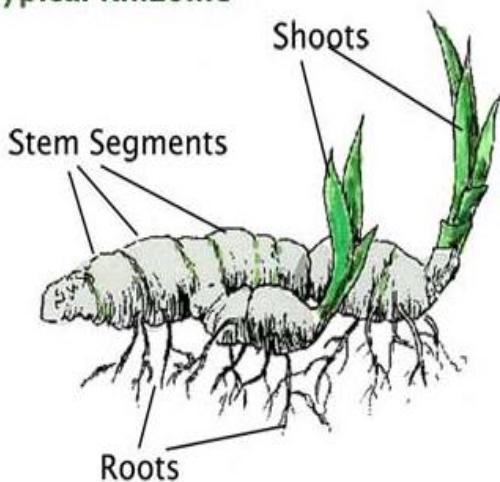


Cocoyam is propagated by using a corm.

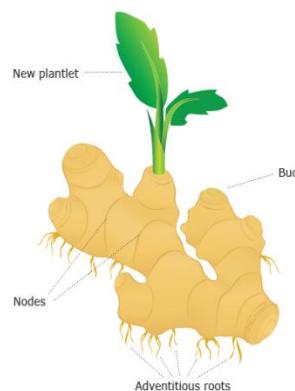
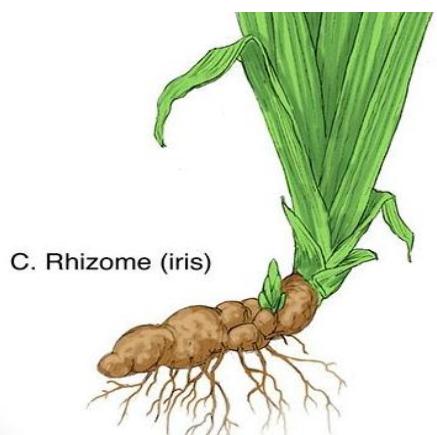
## 7. RHIZOMES

This refers to the thick horizontal underground stem in which food is stored. The new shoots and roots grow from the buds on the rhizome. Examples of crops propagated using rhizomes are ginger, bamboo, grasses and bananas.

### Typical Rhizome



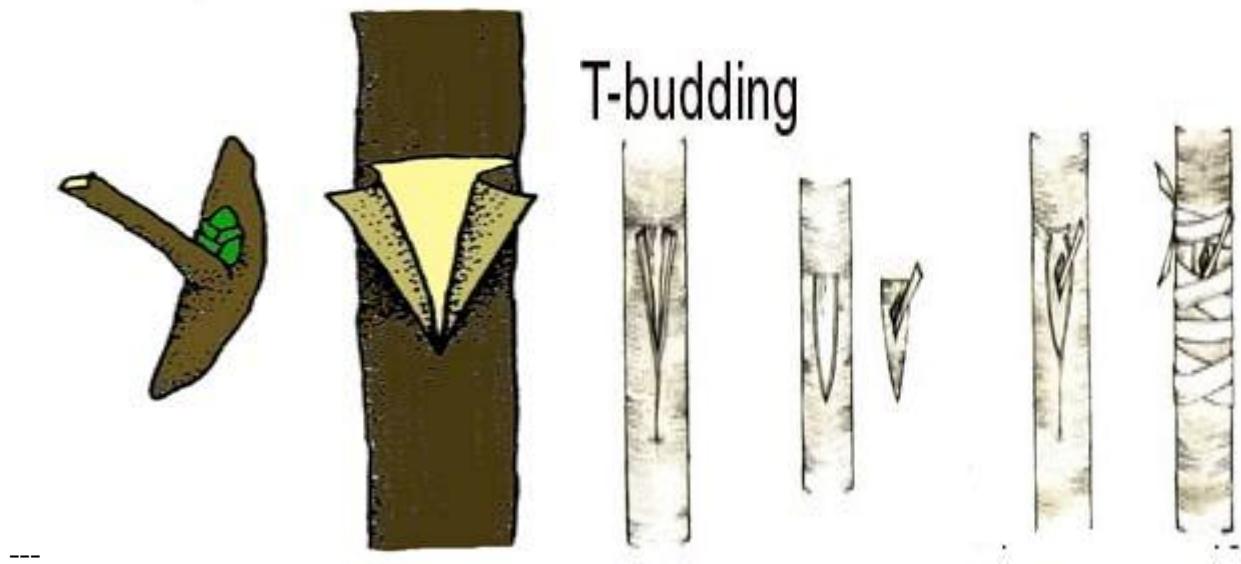
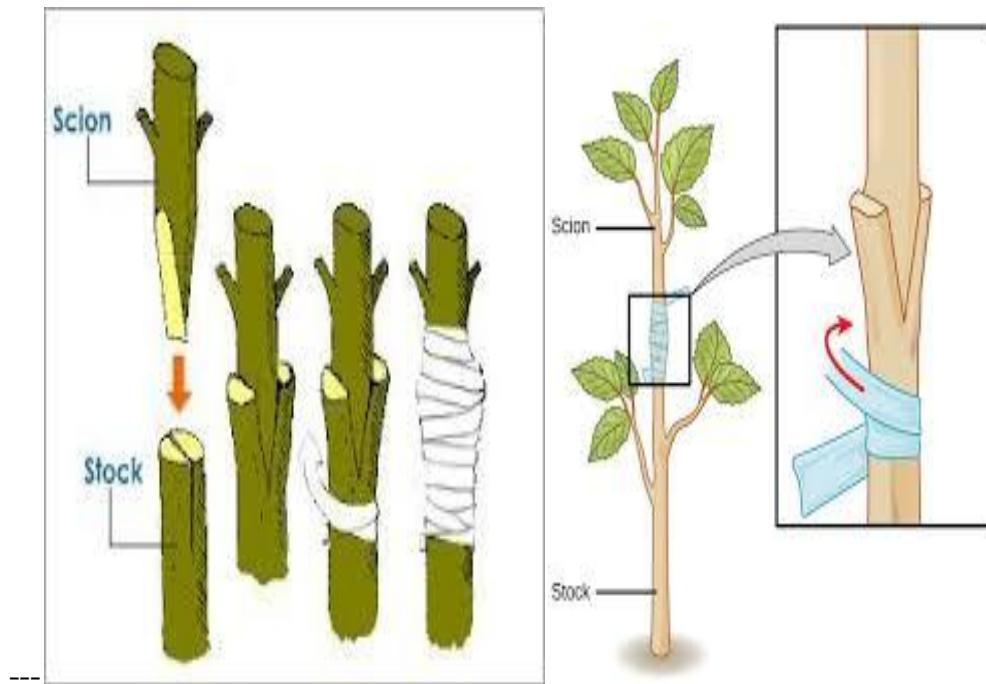
**Vegetative propagation  
by rhizome in ginger**



## 8. Budding

Budding is the method of vegetative propagation where farmers cut away a bud (a plant shooting) from a mature tree branch. They then open up a T-shaped cut into another tree. They transfer the bud into the T-Shaped cut they have made on the other tree. They fix the bud by binding it with a plastic tape or twine. After some days the cells from the bud unite with the cells of the stem into which bud is inserted.

Budding is common in the propagation of rubber, cocoa and citrus trees like tangerines, oranges and lemons. It requires trained people to do the operations.



## 9. LAYERING

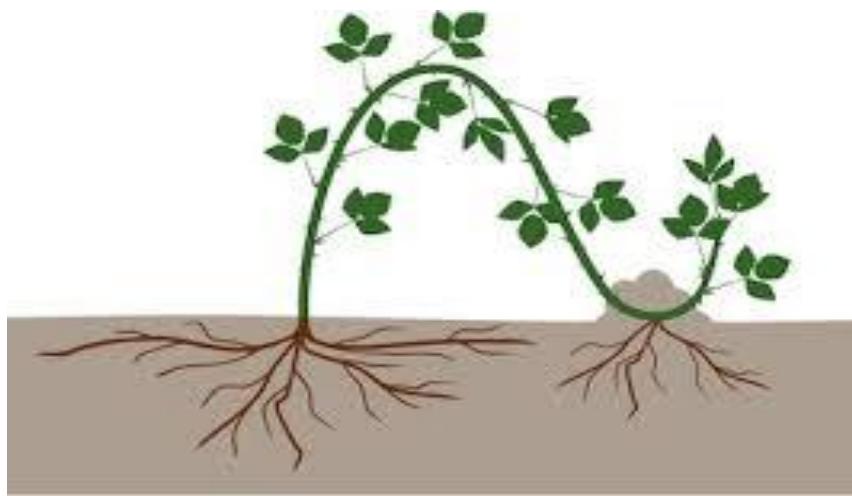
Layering is a process of bending a branch or shoot of a plant to the ground. In layering, farmers allow at least nodes to touch the ground so that they are able to

develop shoots. They pin the branch under the ground but leave the rest of the shoot outside. Later, they cut the branch when roots have formed.

This takes the form of **air layering** and **ground layering**.

### AIR LAYERING

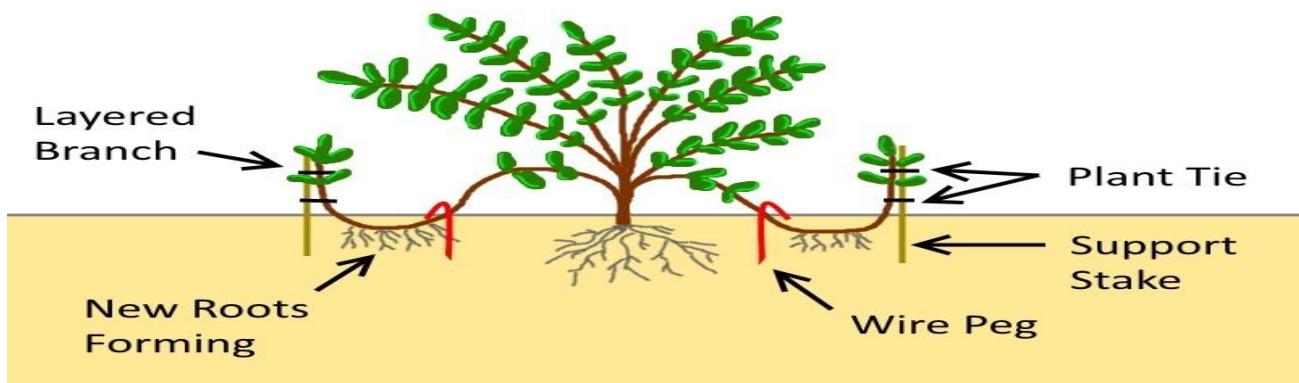
- This is where a branch of the plant is wounded and the wound is covered with soil but the branch will usually develop roots while it is attached to the plant. It is then cut from the parent and grown as a new plant.



### Ground layering

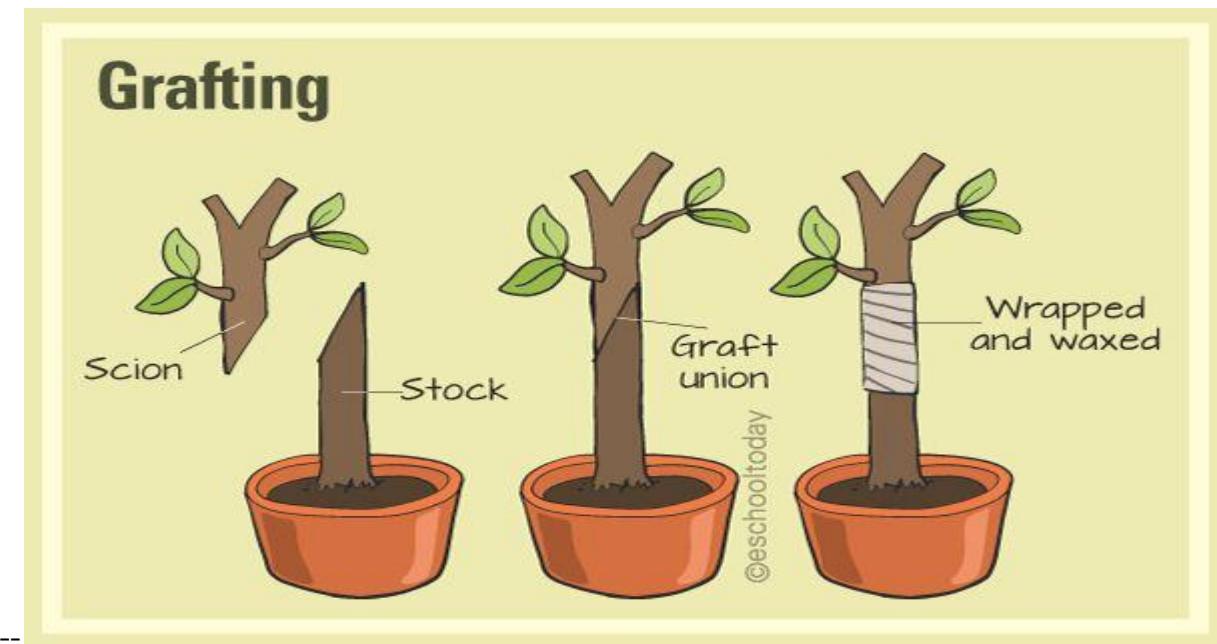
It is where a branch of the tree is pegged down to the ground so that it can develop new shoot while it is still attached to the plant.

#### Propagation Technique - Simple Layering



## 10. GRAFTING

- Grafting is the joining up of two woody stems. The stem on the ground which has roots is the **stock**. The shoot of another plant which specialists join to the stock is called a **scion**. The two plants must be of the same age and size. This will make the two plants to unite easily after grafting. The plants should be of the same species or very closely related for example, tangerines and lemons.
- When grafting they cut the scion and stock in a slanting or V-Shape. They then fit the **scion** to the **stock**.
- The diagram below shows the how grafting occurs.



### **GUIDELINES TO SUCCESSFUL GRAFTING**

- ✓ Use healthy and vigorous rootstocks from desirable cultivars.
- ✓ Obtains scions from the terminals at the start new growth.
- ✓ Apply adequate amount of water to the rootstock before grafting
- ✓ Apply adequate amount of water at the root zone.
- ✓ Remove shoots that develop from below the graft zone.
- ✓ Avoid application of manure and fertiliser during the first year of grafting to facilitate proper healing.
- ✓ Ensure that the stock and scions are firmly bound together. etc.

### **ADVATAGES OF VEGETATIVE PLANTING MATERIAL**

1. Vegetative planting materials are readily available to farmers from the previous crops
2. Vegetative planting materials have enough food reserves that can be used to sustain growth of the new plant. This increases survival rate of the new plants.
3. It ensures genetic uniformity as much the offspring resembles the parents.
4. Reduces dormancy as it is the case with some seeds such as tomatoes which need to be dried first before they can germinate.
5. They provide the only way of propagating crops whose seeds do not germinate or do not breed true.
6. Plants propagated by this method grow faster and mature earlier than those established using seeds. This is because large amount of food reserves that the vegetative planting materials have.

### **DISADVANTAGES OF VEGETATIVE PLANTING MATERIALS**

1. They cannot be stored over a long period of time as is the case with seeds because they can wilt and eventually die.
2. They are usually bulky and therefore difficult to transport over a long distance.
3. They need to be handled with care using transportation otherwise their growing points can easily be destroyed.
4. There is a very high risk of transferring diseases from parents' plants to the new plants.
5. It is difficult to introduce variation into the crops. As a result crop improvement becomes difficult.

### **CHAPTER TEN: CROPPING SYSTEMS**

- Cropping system refers to pattern, techniques, procedures which are followed in the cultivation and production of plants.

### **CROPPING SYSTEMS PRACTICED BY THE FARMERS**

#### **1. MIXED CROPPING**

- Mixed cropping refers to growing different crops on the same plot during the same growing season.

- It is also called intercropping, interplanting, polyculture or multiculture.
- The diagrams below shows mixed cropping carried out by farmers.



**Intercropping**



## **FORMS OF MIXED CROPPING**

### **a. MIXED INTERCROPPING**

This is where crops are mixed without any pattern in the field. Examples are crops grown by broadcasting.

### **b. ROW INTERCROPPING**

This may be intra-row cropping and inter-row cropping.

#### **INTRAROW CROPPING**

Intra row cropping is where two crops are grown on the same row/ridge and crops may be sown on the same station or different. Examples are maize and beans.

#### **INTER-ROW CROPPING**

This is where one crop is grown between the rows of another crop. In other words, crops are grown on alternate rows or ridges.

**c. RELAY CROPPING/PHASE PLANTING**

- This is where a second crop is sown on the plot while the first one is still growing or even maturing. Cassava can be planted in Maize. This is common for maize and beans.
- This practice is successful where rainy season is longer than required by the first crop.

**ADVANTAGES OF MIXED CROPPING**

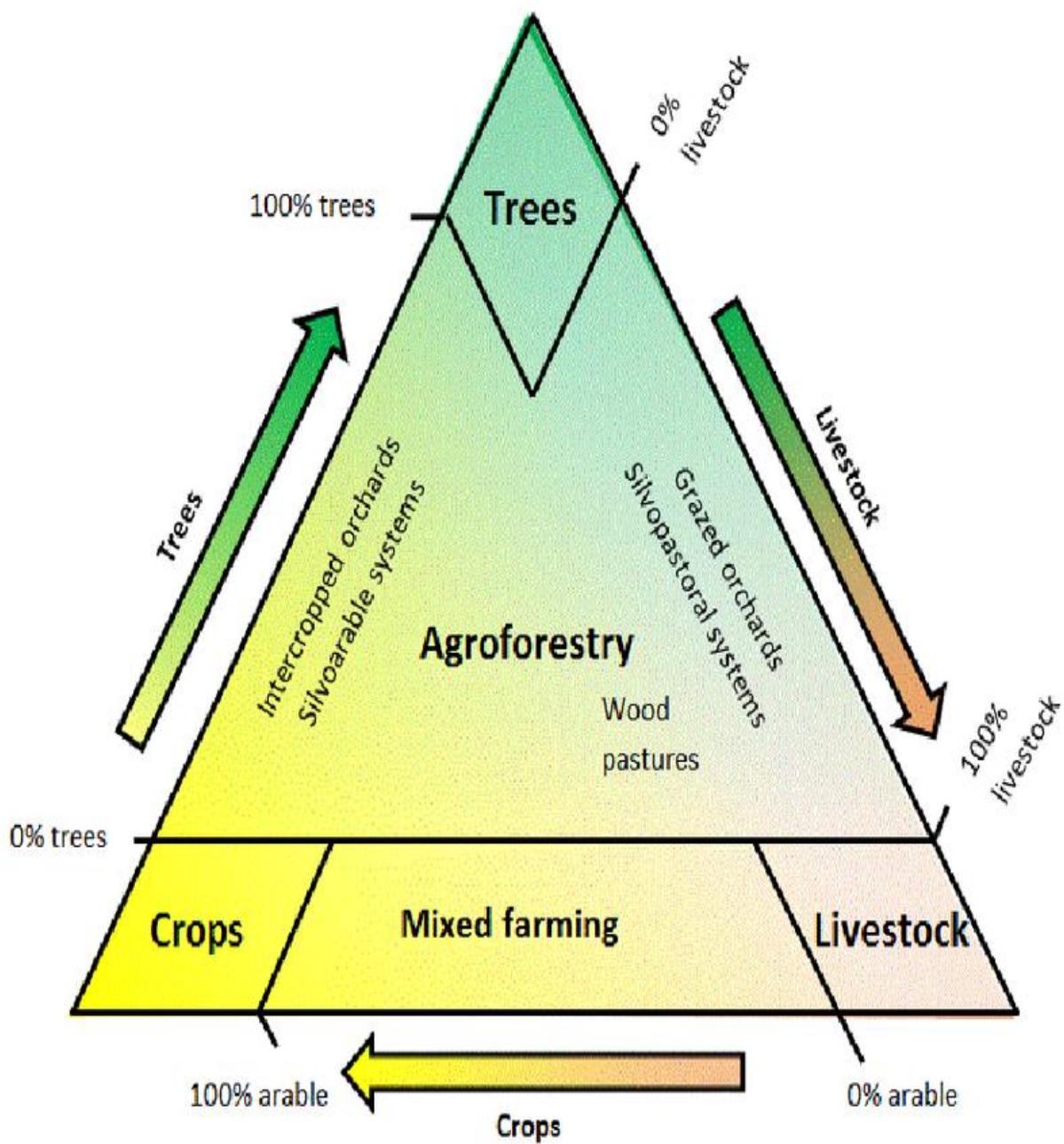
- It saves labour since all operations are done once for all crops.
- It saves land since it is used for more than one crop.
- It increases total yield per hectare.
- It reduces the risk of crop failure since the farmers rely on other crops if one fails.
- It enables crops to benefit from one another. For example beans fix nitrogen which is used by the crop while maize acts a stake for climbing beans.
- It reduces the spread of pests and diseases.
- The mixture of the crops provides adequate soil cover to reduce soil erosion and weed growth.

**DISADVANTAGES OF MIXED CROPPING**

- It requires large starting capital to get different machines and farm structures for the different crops.
- It is difficult to use pesticides, fertilizers or herbicides since chemicals used on one crop may be harmful to another.
- It requires a wide range of knowledge and skills to manage different crops.
- Different crops shade one another reducing the rate of photosynthesis.
- Mechanization is difficult since each crop has specific needs in terms of operations like ploughing and ridging.

**2. AGROFORESTRY**

- Agroforestry is a cropping system in which agronomic crops are grown in association with forest trees.



- In Agroforestry, trees are planted in such way that they leave a strip of land where agronomical crops are grown.
- Trees are usually planted either to the east-west directions so that sunlight can still reach the field crops. Most of these plants are leguminous trees used as livestock feeds such as leucamia, sesbania sesban. The diagram below illustrates Agro forestry.

### **AGRO-SILVICULTURE**

- This is the practice of growing of field crops and trees, shrubs together on the same piece of land.
- This involves planting rows of field crops to be followed by rows of trees. The spacing of the rows should be large enough to allow the crops access the sunlight.

**Agrisilvicultural systems, which manage land for the production of agricultural crops and forest trees .**



### **SILVOPASTORAL**

- This is the practice where trees/pasture are grown in association of rearing livestock. This means that the farmers can grow forest trees or fruit trees with pasture. 8-20 metres space for trees before the next strip of pasture can be enough.

**Silvopastoral systems, which produce both wood products and livestock (animal) .**



### **AGROS-ILVILVOPASTORAL**

This is the practice which involves growing crops, rearing livestock and growing trees and pasture.

**Agri-silvopastoral systems**, a mixture of the two systems above, which produces tree products, crops, and livestock.



### **ADVANTAGES OF AGROFORESTRY**

- a. The farmers have a large source of income base because a part from agronomic crops, the farmer can sell poles, fuel wood and timber.
- b. The farmers maximize the use of land resources since trees are deep rooted plants. They get their nutrients from deep horizon and bring them to the surface as the leaves fall and decompose.
- c. It helps to improve fertility through fixation by legumes.
- d. It helps to control soil erosion. The roots open up soil thereby encouraging water infiltration while at the same time their foliage intercepts rain drops before falling to the ground. In return, they help to conserve water.
- e. The trees protect the crops from strong wind.
- f. Legume trees such as leucaena are good animal feed.

### **DISADVANTAGES OF AGROFORESTRY**

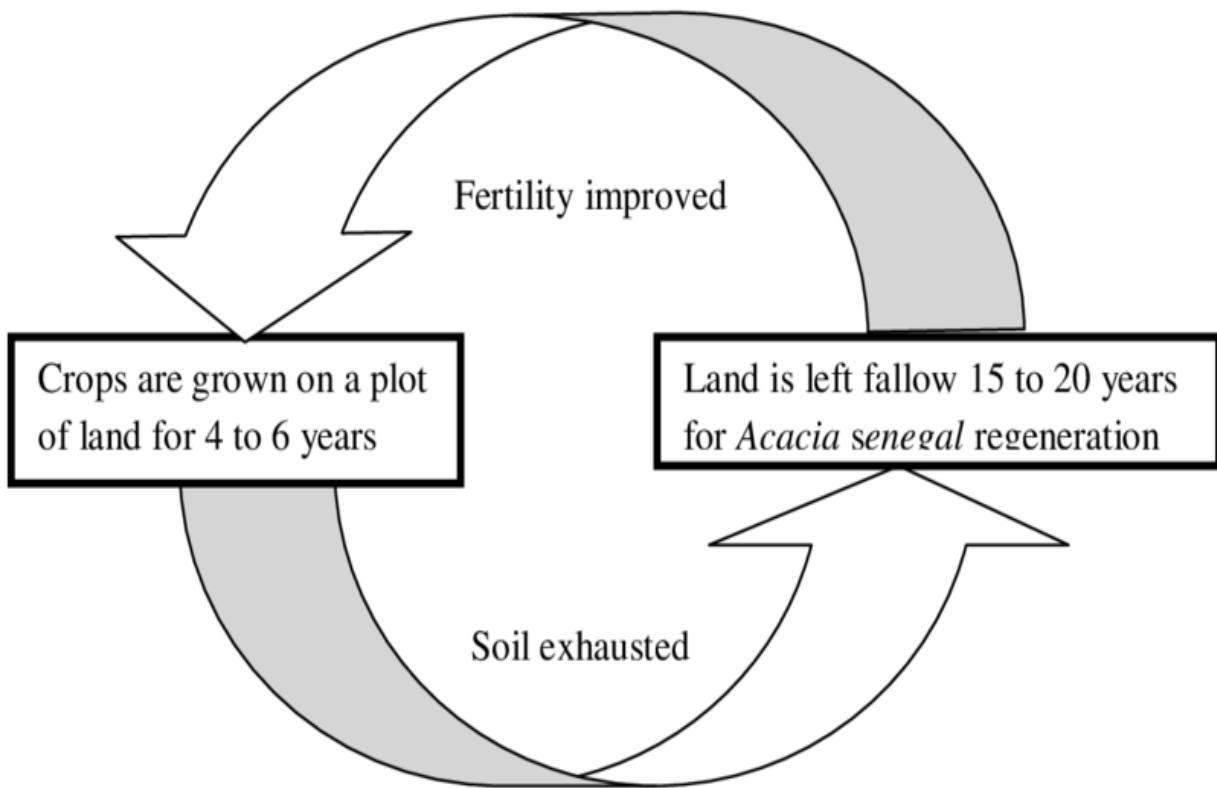
- Agronomical crops may not produce high yield because of shading from trees.

- It cannot be practiced where land is scarce to cater for both trees and the field crops.
- There is high labour demand as the trees may need regular pruning to ensure that there is limited shade in the field of crops.

#### **g. BUSH FALLOWING**

This refers to farming a plot temporarily leaving it when exhausted to remain fertility, then returning to it later. The fallow period may be five to ten years. The diagram below illustrates bush fallowing.

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#### **Advantages of bush fallowing**

- It is cheap since it does not need a lot of capital for fertilizers.
- It maintains soil fertility.

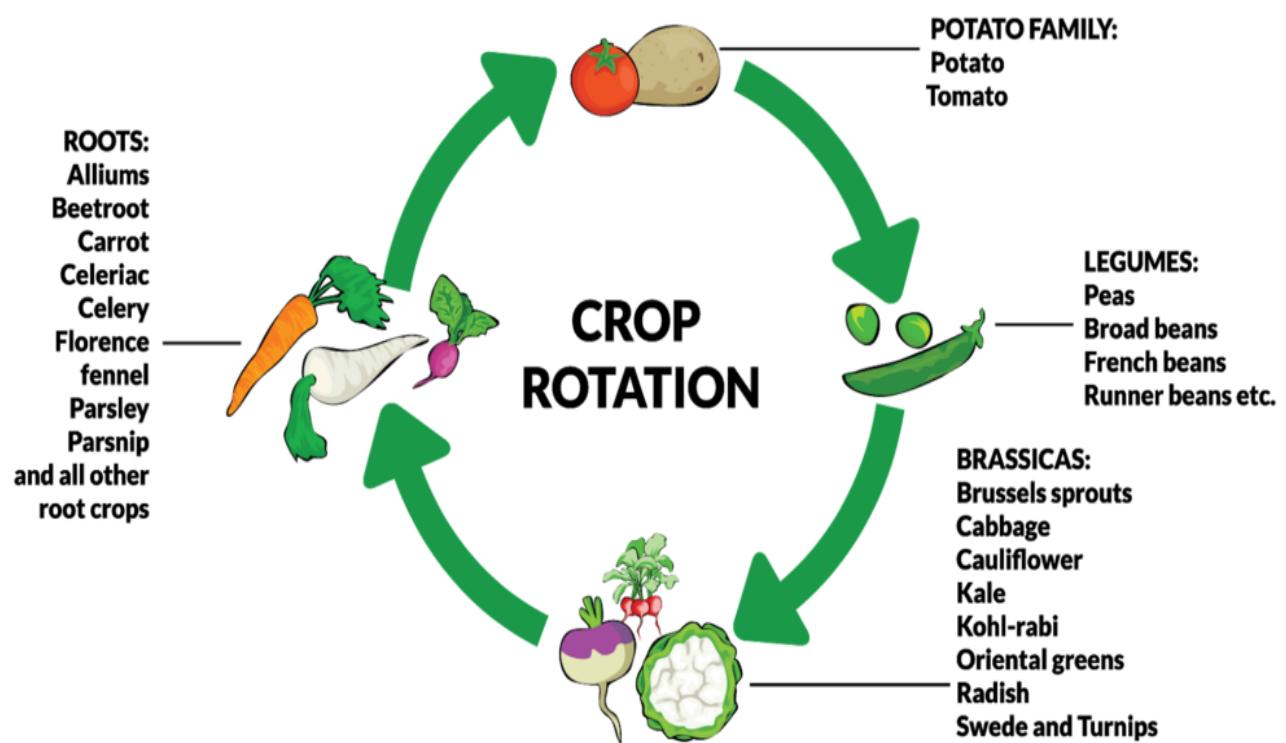
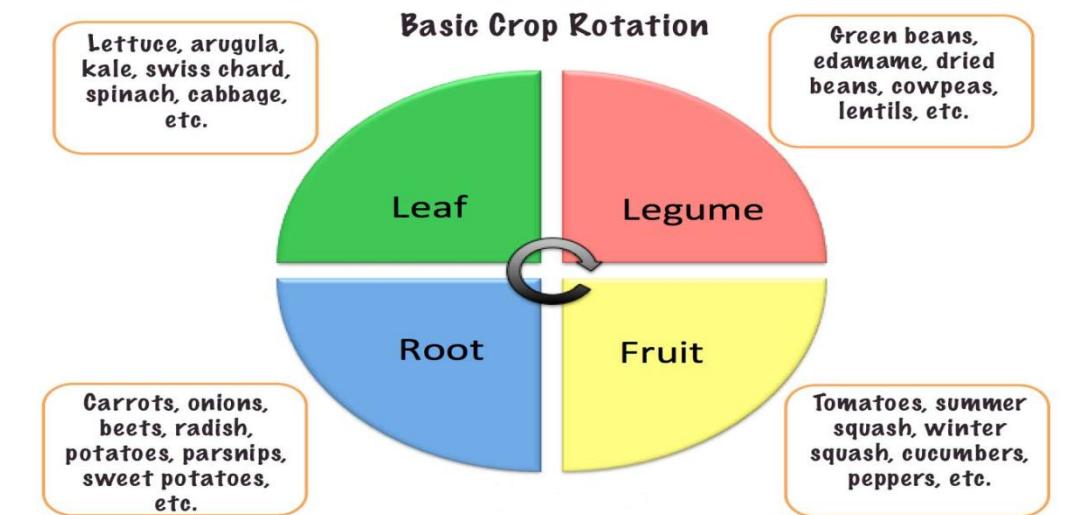
#### **Disadvantages of bush fallowing**

- It encourages deforestation
- It increases soil erosion because land is left bare.

- It requires a lot of land.

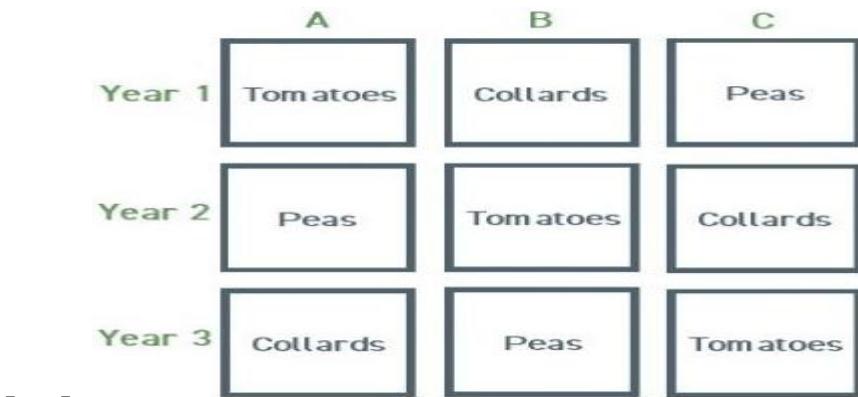
#### **h. CROP ROTATION**

-This is the practice of growing different crops on piece of land in particular sequence or order every year. The diagram below illustrates crop rotation.



- The farmer decides on the crops to grow depending on climate, soil type, amount of land, capital, labour and managerial ability.

- The length of rotation depends on the crops to be grown, for example, six year rotation a farmer should divide the land into six plots. Each crop return to its original plot after six years.
- Below is an example of crop rotation sequence



### **THE PRINCIPLES OF CROP ROTATION**

- a. Alternating tap深深 rooted crops with fibrous/shallow rooted crops.
- b. Alternating leguminous crops such as beans, groundnuts and peas with non-leguminous crops such as cotton, tobacco and cereals.
- c. Alternating crops that are resistant to specific diseases with susceptible crops to those diseases.
- d. Alternating crops with good soil cover with those having little soil cover.
- e. Alternating heavy feeders with light feeders.

### **ADVANTAGES OF CROP ROTATION**

- a. It ensures that plants make full use of nutrients from different layers in the soil.
- b. It maintains or improves soil fertility if legumes are included in the rotation.
- c. It controls pests and disease by breaking their life cycles.
- d. It controls parasitic weeds which are hosts specific by depriving them of their host on the plot in some years e.g. witch weed associated with cereals.
- e. It reduces soil erosion when cover crops are included in the rotation to cover and protect the soil against raindrops impact and run-off.
- f. It ensures even distribution of labour demand throughout the year so that serious labour peak months may not occur.

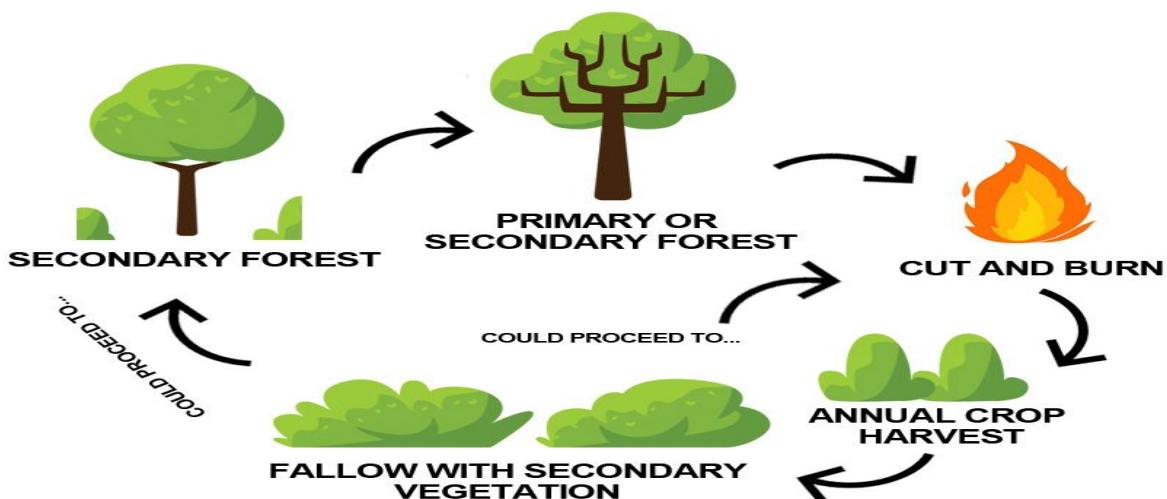
g. It spreads financial risks over several crops.

### **DISADVANTAGES OF CROP ROTATION**

- It results in less farm income compared to monoculture since some crops in the rotation may have low commercial value.
- It requires more land to accommodate the various crops.
- It requires more labour since some crops in rotation needs more labour.
- It requires skills in management of various crops which the farmers may not have.
- It may not be practical where the farmer needs to use over 90% of land for staple food crop each year to meet family food requirements.

### **i. SHIFTING CULTIVATION**

This is where the land is cultivated for several years until yield become low due to soil exhaustion, and then it is abandoned for another one.



No fertilizers are applied and nutrients are added in the form of ash (potassium and calcium) after burning. The diagram below illustrates shifting cultivation.



The following are the cycle activities involved in shifting cultivations

- a. Clearing the land
- b. Cultivating the area continuously for several years.
- c. Evaluating crop yields each year
- d. Abandoning the area when yields are too low
- e. Moving to farm a new area

**j. MONOCULTURE**

This is the practice where different crops are grown on a farm occupying separate plot each. This means that each plot has pure stand, that is, it carries only one crop at a time.

**ADVANTAGES OF MONOCULTURE**

- a. Mechanization is easy
- b. It eliminates competition from other crops.
- c. It is easy to use chemicals such as pesticides, herbicides or fertilizers in pure stands.

**DISADVANTAGES OF MONOCULTURE**

- a. There is less total yield per unit area as compared to mixed cropping.
- b. Pests and diseases can easily spread because there are no trap plants in the field.

**k. MONOCROPPING**

This is the practice where the farmer solely grows one crop on the farm and nothing else.

**ADVANTAGES OF MONOCROPPING**

- a. It reduces the start-up capital because the farmer invests in one crop.
- b. The farmer specializes in the management of the crop and as a result, it becomes very easy to perform the operations with precision.
- c. Crop productivity increases due to specialization because the farmer knows what to do and when.

- d. A farmer makes a lot of profit since she/he enjoys economies of scale because it is associated with large scale farming.
- e. It is easy to mechanize since the entire farm has one crop.

### **DISADVANTAGES OF MONOCROPPING**

- a. Pests and diseases spread very fast because the susceptible host is always available
- b. There is much higher risk of total crop failure because farmers grow only one crop.
- c. If the farmer grows, non-cover crop, the soil is subject to erosion.
- d. There is rapid exhaustion of land because the crop uses nutrients from the same soil horizon.

### **I. ORGANIC/BIOLOGICAL/ECOLOGICAL FARMING**

- This is the cropping system where crops are grown using organic inputs such as manure/organic fertilizer rather than inorganic inputs like commercial fertilizers.
- Pests and diseases are controlled physically, culturally and biologically instead of chemically.

### **ADVANTAGES OF ORGANIC FARMING**

- a. It prevents pollution of water reservoirs.
- b. It protects useful insects such as pollinators and predators of pests.
- c. It improves soil structure through organic manures.
- d. It is cheaper to make and apply organic manures.
- e. It reduces chances of poisoning people
- f. It is environmental friendly.

### **DISADVANTAGES OF ORGANIC FARMING**

- a. Organic inputs are slower than inorganic inputs.
- b. Organic inputs may not be readily available for large farms.

### **m. CONTINIOUS CROPPING**

- This is the system of growing crops on a piece of land every year without fallowing.

- Most farmers practice this because they do not have large land holding for fallowing.

### **ADVANTAGES OF CONTINUOUS CROPPING**

- a. It ensures 100% utilization of the land.
- b. It conserves the soil since the land is under cover throughout the year.
- c. It ensures food security or cash for the farmers from the crops harvested from all parts of the farm each year.

### **DISADVANTAGES OF CONTINUOUS CROPPING**

- a. It exhausts soil fertility since nutrients are removed by crop each year.
- b. It results in over-cultivation or cropping which destroys soil structure.
- c. It results in multiplication of pests and diseases and some parasitic weeds.

### **CROPPING SYSTEMS WHICH CAN PROMOTE CROP YIELDS**

#### **1. MONOCROPPING**

- It is the practice of growing a single crop year after year on the same land.
- It promotes crop yields in the following ways
  - a. It allows specialization in equipment and crop production techniques because operations are carried out by the farmers repeatedly year after year. This in turn increases crop yields
  - b. The farmers choose an enterprise that they are highly conversant with and whose capital resources they can afford
  - c. Crops are grown independently and as a result it is easy to determine right quantities of inputs such as fertilizers, pesticides. It is also easy to mechanize the farm operations that make farmers to carry out operations in time and also cultivate large farming holdings
  - d. Crops do not compete for growing resources such as space, nutrients, water, light etc.

#### **2. MONOCULTURE**

- It is the cropping system where the farmers grow a wide variety of crops in pure stand.

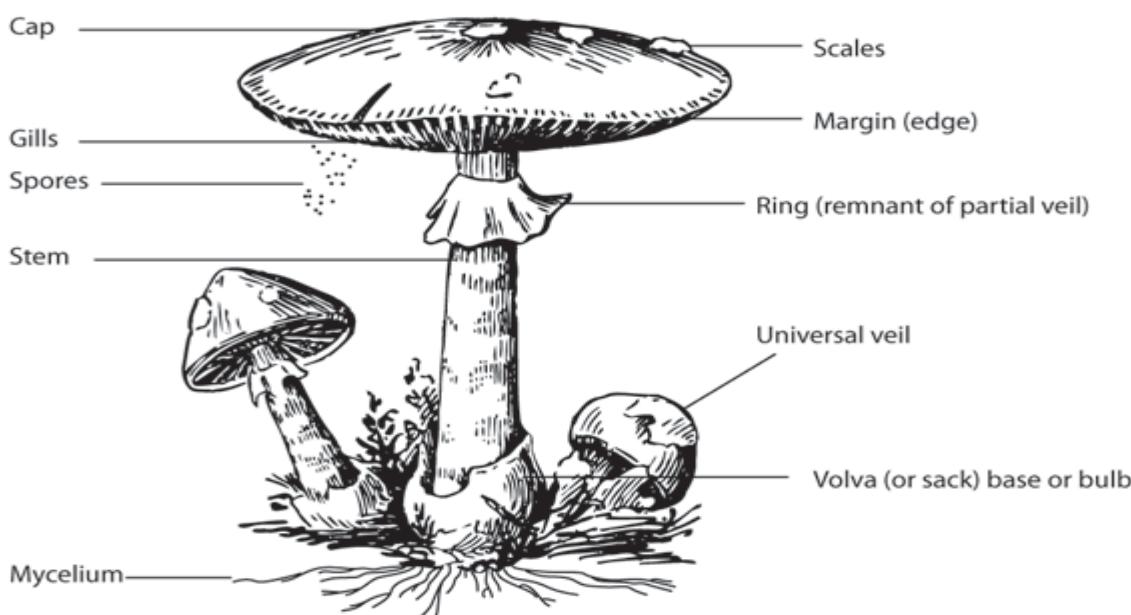
- This system can promote crop yields because
  - a. It can encourage which can help to enrich the soil and control crop disease.
  - b. It maximizes land utilization ad for instance, if the land is made of swampy it can be used for paddy rice and hilly can be used for silviculture

### **c. ORGANIC FARMING**

- This is the cropping system where crops are grown using organic inputs such as manure/organic fertilizer rather than inorganic inputs like commercial fertilizers.
- This system can promote crop yields because
  - a. The farmers need not high capital investment in order to produce crops.
  - b. It can bring everyone on board and make those landholdings which are presently failing to produce lack of inputs become productive.

## **CHAPTER 11: MUSHROOM PRODUCTION**

- Mushroom are fruiting bodies of a certain class of fungi called Basidiomycetes.
- Mushrooms are common during the rainy season.
- Mushrooms provide supplementary food. However not all mushrooms are edible.-
- Examples of wild edible mushrooms are Nyozwe, Chifwiwi and utale



## **THE CHARACTERISTICS OF FUNGI**

1. They have no chlorophyll and hence cannot produce their own food like other plants.
2. They depend on other organisms for food, absorbing nutrients from the organic material in which they live. They obtain nutrients by absorption.
3. They reproduce through **spores** or by budding. The living body of the fungi is the mycelium which is made of thread-like called **hyphae**. See the spores and hyphae-in the diagram below

### **THE -CLASSI-FICATION OF MUSHROOMS**

The three classification of fungi include

#### **1. Saprophytes**

These live on dead material or organic debris

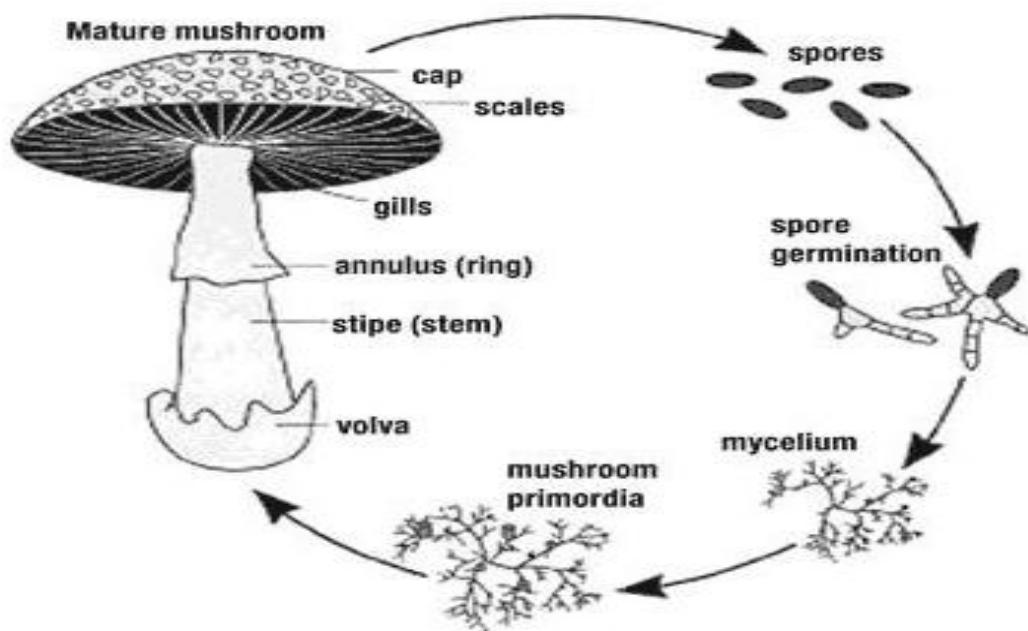
#### **2. Symbionts**

These live together with other organisms in a close relationship known as symbiosis.

#### **3. Parasites**

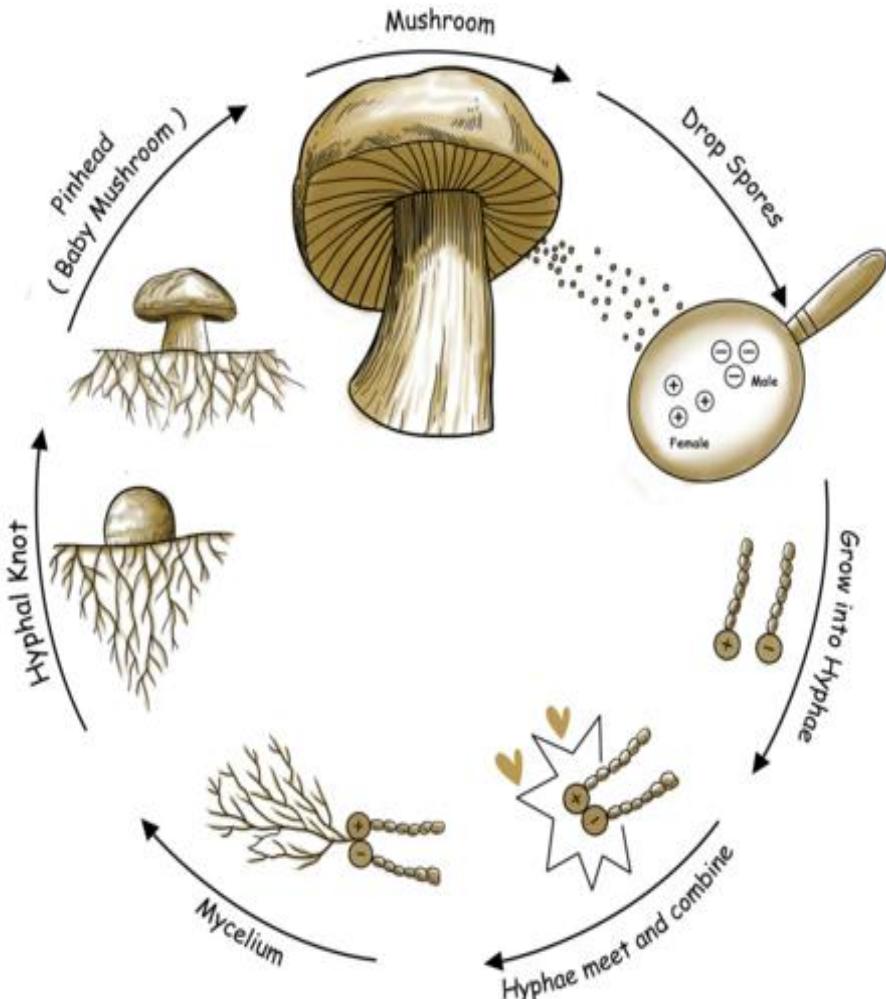
These live at the expense of organisms

### **LIFE CYCLE OF THE MUSHROOM**



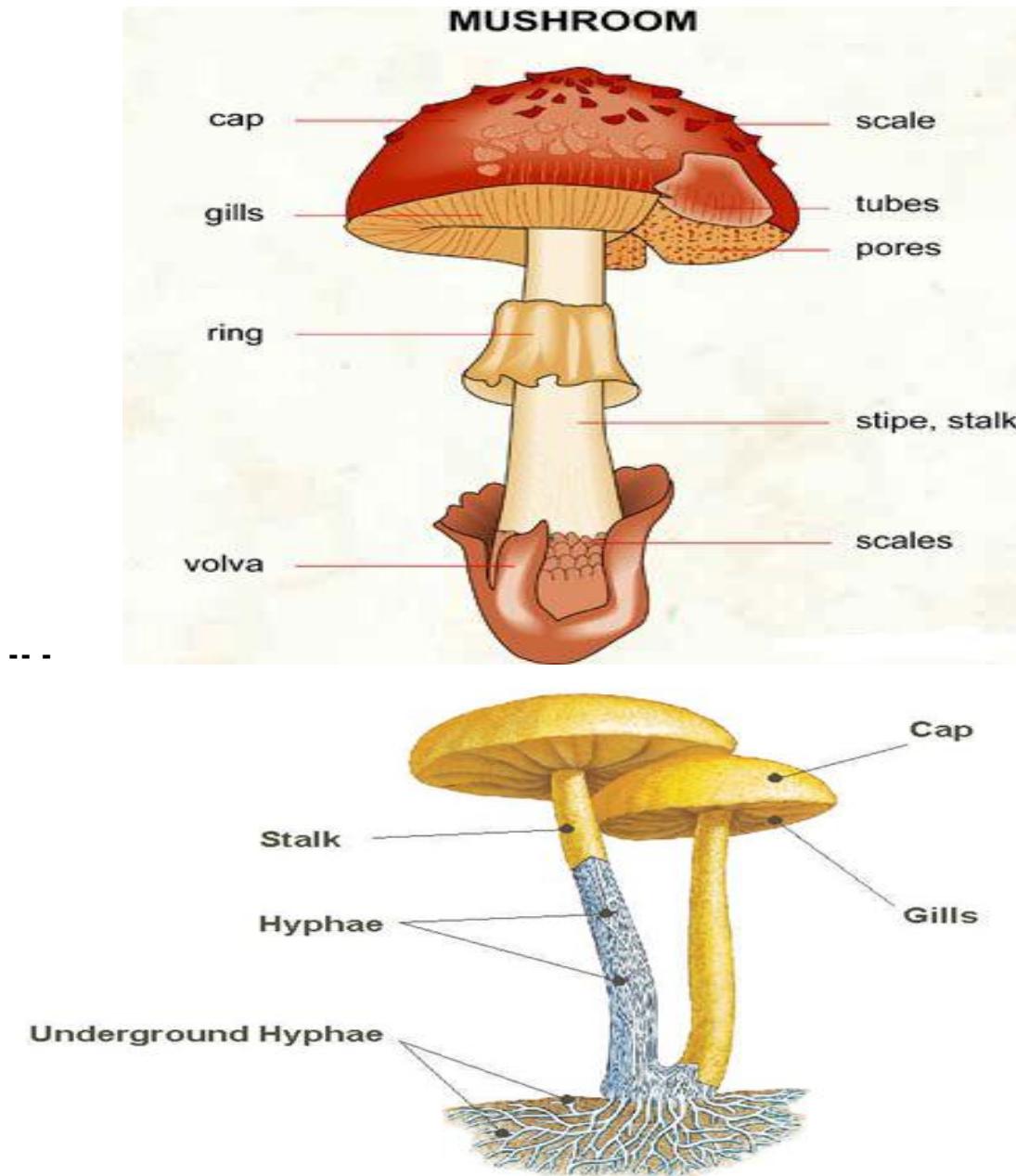
- The cap produces spores which upon failing on a favourable environment will germinate to form mycelium.
- The mycelium forms secondary mycelium through the fusion of two sexually but compatible mycelium.
- Secondary mycelium form the fruiting body called mushroom.

### LIFE CYCLE OF THE MUSHROOM



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### **THE TYPES OF MUSHROOMS GROWN IN MALAWI**

The two types of mushrooms that are grown in Malawi are

## **1. OYSTER MUSHROOM (*Pleurotus spp*)**

- This is a relatively new type of mushroom in Malawi and is picking up very well.
- It is very versatile and easy to be grown unlike button mushroom because of its low inputs requirement and nature.
- The yields are very elastic, varying from one substrate to another.
- Biological efficacy ranges from as low as 20% to as high as 10%
- They do better in temperatures ranges from 15 Degrees Celsius to 30 Degrees Celsius.
- They can be grown on most lignocellulosic agricultural and forestry wastes.
- Most of the substrate requires pasteurization to give economic yields
- Oyster sajor caju which is highly adaptive, prefers temperatures of between 20 Degrees Celsius and 24 Degree Celsius while Pleurotus oesatus grows very well at temperatures between 12 Degree Celsius and 20 Degrees Celsius

## **2. BOTTOM MUSHROOM**

The two varieties which are recommended are

### **a. TNS 1**

- It requires a cropping temperature of 16 Degrees Celsius
- It is white in colour
- It has potential yield of 15 kg per square metre.

### **b. TNS 2**

- It requires a cropping temperature of 18 Degrees Celsius to 22 Degree Celsius.
- It is bigger than TNS 1.
- It is white in colour and scaly with a potential yield of 15 kg per square metre.
- The temperatures are prevalent between March and July in most parts of the country. It is grown best between the months of March and July.

## **DIFFERENCES BETWEEN OYSTER MUSHROOMS AND BUTTON MUSHROOMS**

1. Oyster Mushrooms are easier to grow than button Mushrooms
2. Button Mushrooms have better taste than Oyster Mushrooms
3. Oyster Mushrooms are less capital intensive than Button Mushrooms

4. Oyster Mushrooms have shorter shelf life than Button Mushrooms
5. Oyster Mushrooms fetch lower prices on the market than Button Mushrooms
6. Button -Mushrooms require special compost and fertilizer and hence farmers find it difficult and expensive to produce.
7. Oyster Mushrooms are good for beginning mushroom growers because they are easier to grow and are less capital intensive.

### **THE IMPORTANCE OF MUSHROOM PRODUCTION**

1. They are a source of food, providing proteins, vitamins and minerals which are vital for good health.
2. They are a good source of income to growers.
3. They are source of foreign exchange.
4. Mushroom production can assist in diversification and provides a better way of utilizing crop, forestry and animal wastes.
5. After cultivation, the substrate can be used as manure.

### **HUSBANDRY PRACTICES FOR MUSHROOM PRODUCTION**

- **Selection of species**

When selecting species of mushroom, the farmer should consider

- a. Availability of Market
- b. Temperature ranges for fruiting. Varieties like Oysters and Button Mushrooms do well at temperature around 30 Degrees Celsius.

- **Site selection**

The farmer should consider the following factors when selecting site for mushroom production

- a. They can easily get quality substrate and spawn.
- b. Availability of clean water
- c. Closeness of the market
- d. Transport is readily available to get the produce to the market.
- e. Availability of labour.

### **THE TYPES OF AGAR SUBSTRATE**

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The two types of agar substrates include

**a. MALT EX-TRACT AGAR**

- Add 20g of the extract to 1 L of water and 18-20g of agar
- Heat until the agar is dissolved.
- Put int-o bottles
- Plug and sterilize

**NB:** Malt extract can be available in both syrup or powder and they are normally found with amateur beer makers.

**b. POTATO DEXTROSE AGAR(PDA)**

- Wash and weigh 200g of European potatoes or ordinary potatoes and cut them into small pieces.
- Boil for 15 to 20 minutes in 1L with fresh water until they are soft. Drain and save water.
- Make water back up to 1L with fresh water; add 20hm dextrose and 18-29gm agar.
- Heat until the agar dissolves.
- Put the agar into the containers, plug and sterilize at 121 Degrees Celsius for about 15 minutes.
- Culture medium is poured into test tubes (1/4 full) or Petri dishes (1/2 full).
- Let the medium cool on the laminar airflow table.

**NB:** Laminar airflow table is an enclosed bench designed to prevent contamination of biological samples. The device separates air flowing it into layers.

**• Spawn source**

- It can bought or prepared on the farm
- Spawn is the actual seeds for mushroom. It is prepared in a clean laboratory under very strict hygienic condition to avoid contamination.
- The process followed includes tissue culture preparation. which has two stages namely

**a. Culture medium preparation**

Culture medium is the substance on which mycelium fungi will be grown.

### b. **Tissue culture preparation**

- Inoculating the culture in test tubes or Petri dishes.
- Spawn multiplication using materials like sorghum, millets and whole rice
- Further multiplication of spawn into culture into generations

### **TISSUE CULTURE COLLECTION AND PREPARATION**

- Get mushroom tissue from a desired fresh mushroom species.
- The mushroom is broken using hands washed in alcohol
- The tissues between the gills and the upper part is cut using a razor blade and removed using a clean forceps.
- Using sterilized forceps, the tissue is placed in test tubes or Petri dishes and covers the Petri dishes with cello tape or masking tape while test tubes are plugged with cotton wool.
- Place the test tubes or Petri-dishes in incubator at temperature not below 25 Degree Celsius or above 30 Degree Celsius.

### **Spawning (Spawn Colonisation)**

- Sorghum, millet and whole rice are suitable for spawn making.

### **Procedures**

- Soak the materials in water for a day.
- Remove water
- Sterilize the material at 121 Degrees Celsius for 30 minutes.
- Prepare 300 millimeters bottles that can withstand and sterilize them or 15 minute.
- Put the materials into bottles (3/4 full)
- Sterilize them again for 30 minutes.
- Cool the materials.
- Inoculate the tissue culture into the bottles containing sorghum/millet/rice or wheat. With one Petri dish, you can inoculate 16 bottles. This is called **generation 1**. Each of the 16 bottles can be used to produce 10 bottles of

spawn, making a total of 160 bottles of spawn. This is **generation 2**. Each of the 10 bottles in turn can be used to produce another 10 bottles of spawn. This is **generation 3** and is the one that the farmers use to grow mushrooms.

- Put the inoculated bottles into an incubator for 15 days. Mycelium would have colonized the material by that time.

### **INSTITUTIONS THAT PRODUCE THE SPAWN**

These include

- a. Natural Resources College
- b. Bvumbwe Resource Station
- c. Chancellor College
- d. Bunda College.

It is recommended that spawn be bought from such institutions for successful mushroom production.

### **MUSHROOM PRODUCTION**

Mushroom Production involves three main activities

- a. House construction
- b. Substrate preparation
- c. Management

- **Construction of incubation and fruiting house**

#### **INCUBATION HOUSE**

- Walls and roofs are covered with black plastic sheets
- Should have the shelves made from bamboos or wooden sticks.

#### **PRODUCTION HOUSE/FRUUITING HOUSE**

- Roof should be covered with black plastic sheets
- Walls should be covered with clear Plastic sheets to allow sufficient light.
- Should also have the shelves.
- The size of the house should vary depending on the amount of mushrooms you want to produce.

- The floor should be solid and sloping for easy cleaning and to allow water to drain. Sand should be placed on the floor since it absorbs water.
- The house should face the windward side and should be shielded from the sun. It should be well ventilated.

**• SUBSTRATE PREPARATION**

Farmers in Malawi use chopped maize stalks when preparing substrate.

**PROCEDURES**

- Chop the maize stalk into pieces of 2.5cm in length.
- Soak the substrate material for sometime
- Remove the water and dry the materials. Ensure that it is not too dry.
- Keep the materials under shed.
- Fill the materials firmly in clear plastic bags.
- Tie the bags with sisal or rubber band.

**THE PROCESS OF STERILISING THE SUBSTRATE**

- Put 10 litres of water in the drum. Cover with perforated round metal sheet or wooden rack.
- The wooden rack or perforated metal sheet and side of the drum should be covered with cardboard. This is to protect the plastic bags from the heat.
- Fill the drum with the substrate material and cover it with black or clear plastic sheet. Make a hole in the middle of plastic sheet to serve as safety valve.
- Tighten the drum with sisal.
- Put the drum on fire and heat it for at least 1 hour. Maintain the fire at 110 Degrees Celsius. This is to ensure that the material is thoroughly sterilized against bacterial and other fungi eg trichoderma which is the green mould, a common disease of oyster mushroom.

**SPAWNING THE SUBSTRATE**

- Wash hands with alcohol
- Spawn bottles should be made in the bags for aeration to enable mushroom to sprout.

- Bags should be placed on shelves and covered with plastic sheet.
- Incubation- takes 21 days. During this period, the mycelium will colonize the substrate and start to form small fruiting bodies.

### **FRUITING/CROPPING**

- The colonized bags should be taken to a fruiting house.
- During fruiting, it is important that the house should be kept damp but wet to allow the mushroom to grow. This is done by watering the bags three times a day depending on weather conditions.
- Temperature of the fruiting house should not be more than 20 Degrees. This can be achieved by opening the doors and windows at night, and watering the house.-

### **MUSHROOM FRUITING MANAGEMENT**

- In Mushroom Fruiting management, if the substrate bags turn green or pink in any part show signs of white mycelium growth then the ambient temperature may be too high. If mushroom mycelium does not grow but other moulds grow, it means temperatures are too low.
- If mycelium has not grown at the bottom of the bag indicates that the substrate is too wet.
- If the mushrooms are wrinkled and brown at the edges then it has been too dry during growing and more moisture should be provided during growing stage. They need to be sprayed with water on a regular basis.

**CASING** - Casing is the addition of moisture pasteurized soil onto the compost. It must be a clay loam sub soil, low in organic matter content and PH between 7.0 and 7.5.

- It is done after 14 days when compost is completely colonized by mycelium.
- It is put on top of compost for about 3 to 4 cm and about 30kg of soil is required per square metre
- The casing should be moist all the times and the temperature should be between 16 Degrees Celsius and 22 Degrees Celsius.

- Mushroom pinheads start forming from day 16 after casing.

### **IMPORTANCE OF CASING**

- It promotes and stimulates formation of fruiting bodies.
- It retains the needed moisture for mushroom growth.

### **HARVESTING MUSHROOMS**

#### **FACTORS TO CONSIDER WHEN HARVESTING MUSHROOMS**

##### **1. Maturity of the mushroom**

- Ready for harvesting when button appear. Buttons are round-topped mushrooms that are still closed. Buttons fetch high demand on the market than when harvesting is delayed/open.
- However, harvesting can be delayed until caps appear. The caps are when the mushrooms veils have opened or are likely to open. The caps are still round topped.
- Farmers can harvest mushrooms when flats appear. At this time, veils open up and the caps are flat with gills fully exposed.

##### **2. Market requirement**

Mushrooms can be harvested at different stages of maturity. This is because of differences in customers' tastes. Most consumers prefer button to rest. This is why they fetch a lot of money on the market. Flats have least demand on the markets therefore fetch very low income.

##### **3. Plucking**

Pluck when fully grown. They are ready for harvesting after 14 to 20 days after casing and they come in weekly flushes.

##### **4. Yield**

Depending on the variety, the yield ranges from 5 to 10kg per square metre under smallholder farming. Cropping period of 8 to 12 weeks is normal and it is possible to grow two crops in a year.

##### **5. Marketing**

Mushrooms are ready for the market into various grades.

Mushrooms grades are divided into the following three grades

**a. Button -**

These are closed mushroom which could be small or big. They fetch the highest price on the market.

**b. Caps**

These are mushrooms whose veils have opened or are likely to open. They normally have a medium value.

**c. Flats**

These are mushrooms whose veils have opened and the caps are flats and gills exposed fully. They normally fetch low prices.

### **PROCEDURE-S FOR HARVESTING MUSHROOMS**

- Hold the cap.
- Twist the mushroom
- Pull it together with the rots.
- Cut off the root
- The hole left behind should be filled with fresh casing soil.
- Watering of beds should be done soon after harvest.

### **PROCESSING OF MUSHROOM**

#### **Describe the processing techniques used to process mushrooms.**

##### **1. Canning**

The mushrooms are preserved in brine, butter oil or vinegar.

The following operations are then carried out

- Grading
- Blanching-(pre-cooking). Mushrooms are immersed briefly in boiling water.
- Can filling in brine solutions
- Sterilization with heat and cooling through water spray.
- Labeling the cans for storage.

##### **2. Individual quick freezing**

- The raw mushrooms are washed at processing units and then impacted, sliced and graded. They are then blanched, water cooled and subjected to tunnel freezing at -40 Degree Celsius.
- The tunnel freezing stage may be replaced with vacuum freeze drying to retain the original couloirs, texture and freshness properties.
- VCF involves cooling the mushrooms much below a temperature of - 40 Degree Celsius where the moisture present in the mushrooms is converted into tiny ice molecules. The ice sublimes into vapour when subjected to vacuum with a slight rise in temperature resulting into a dried product.

### **3. Drying**

This involves sun drying, mechanical drying, air drying and microwave oven drying. After normal drying, vacuum drying process follows which is used to reduce pressure inside the mushrooms.

### **4. Pickling of mushrooms**

- In pickling of mushrooms, white wine, vinegar, salt, sugar, garlic and olive oil are mixed with water and boiled for 12-15 minutes. The mushrooms are removed from the pan and completely dried.
- The dried mushrooms are coated with olive oil which make the mushrooms to remain in good condition for about two months.

### **5. Radiation preservation**

6. The mushrooms are exposed to a radiation of gamma rays to stop the post-harvest growth and deterioration.

### **What is blanching in crop processing?**

This involves immersing the crop briefly in boiling water. It is done to stop certain enzymatic reactions in the leaves and helps retain their colour and flavor.

### **What is involved in pickling in mushroom preservation?**

- In pickling of mushrooms, white wine, vinegar, salt, sugar, garlic and olive oil are mixed with water and boiled for 12-15 minutes. The mushrooms are removed from the pan and completely dried.

- The dried mushrooms are coated with olive oil which makes the mushrooms to remain in good condition for about two months.

**Explain radiation preservation of mushrooms.**

The mushrooms are exposed to a radiation of gamma rays to stop the post-harvest growth and deterioration

**MAIN PESTS OF MUSHROOMS****1. PHORID AND SCIARID FLIES**

- These pests are attracted by the odour of the mycelium. They do not harm the mushrooms as such but they lay their eggs on the mycelium.
- It is the larvae/maggots which eat and damage the stems, gills and mushroom themselves.

**Control**

- The Phorid and sciurid flies can be controlled in the following ways.
  - a. Keeping the fruiting rooms clean
  - b. Removing the old and contaminated bags regularly.
  - c. Setting up fly light traps.
  - d. Nematodes are known prey on the mushroom fly larvae.

**2. RATS**

- Rats are usually a problem if the surroundings are dirty.
- The rats damage the substrate bags.

**Control**

Rats can be controlled in the following ways

- a. Setting traps
- b. Keeping cats
- c. Keeping the surrounding clean.

**3. SNAILS**

Snails eat mushroom at night.

**Control-**

Snails can be controlled in the following ways

- a. By hand picking and killing them
- b. Bats and traps are also used.
- c. Use of salts.

#### **4. MITES**

These are tiny spiders which eat mycelium or the actual mushrooms. They are also carriers or green moulds which are caused by trichoderma and other fungal diseases.

#### **Control**

They can be controlled by

- a. Spraying quicklime
- b. Spraying Malathion.

#### **DISEASES OF MUSHROOM**

##### **These include**

###### **1. Trichoderma, green mould**

- This is common disease of oyster mushrooms
- It is an air-borne and can also come from human handling. It is facilitated by over-heating of the substrate.
- The maximum temperature when pasteurising the mushroom should be maintained at 60°C.
- Green moulds contamination is during spawning.
- The sticky pores are easily transmitted by flies, mites and those picking the mushrooms.
- It also grows when there are cracks in the substrate bags.
- Trichoderma, fungi causes the green moulds appear as spots on dead mushrooms and substrate.
- Once the substrate is infected, the disease causes complete destruction of the mushroom.

###### **2. Dry bubble**

This is a fungal disease caused by **Verticillium fungicola**.

**Damages caused**

- a. Distortion and spotting
- b. Mushroom stems with tilted cap.
- c. Mushrooms are deformed

**Control**

It can be controlled by

- a. Proper hygiene and sanitation
- b. Sterilization of substrate

**3. Wet bubble**

It is the fungal disease caused by **Mycogone perniciosa**

**Damages caused**

- a. Mushrooms are deformed

**Control**

- a. Use of bacterial and actinomycetes as biological measures.
- b. Steaming at 54.4°C for 15 minutes
- c. Spray benomyl.

**4. Cob web**

It is -the fungal disease which is caused by **Cladobotryum dendroides**.

**Damage caused**

Soft rot or decay of fruiting body

**Control**

It can be controlled by

- a. Sterilization
- b. Sanitation and hygiene through regular cleaning and removing dead mushrooms
- c. Spraying fungicides such as chlorinated lime.

**CHAPTER 12: LIVESTOCK FEEDS AND FEEDING**

**GROUPS OF SOURCES OF ANIMAL FEED-STUFFS**

**These include**

## **1. ROUGHAGE**

Roughages are feeds from plant matters

### **CHARACTERISTICS OF ROUGHAGES**

The following are characteristics of roughages

- a. High moisture content
- b. High fibre content
- c. Low protein content
- d. Low digestibility due to higher fibre content
- e. Succulent or green

### **TYPES OF ROUGHAGES**

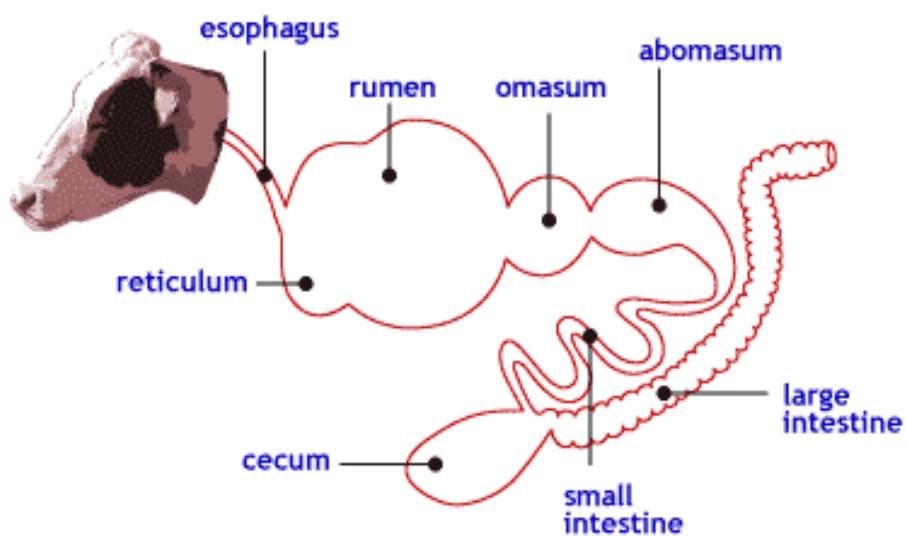
#### **A. SUCCULENT OR GREEN ROUGHAGES**

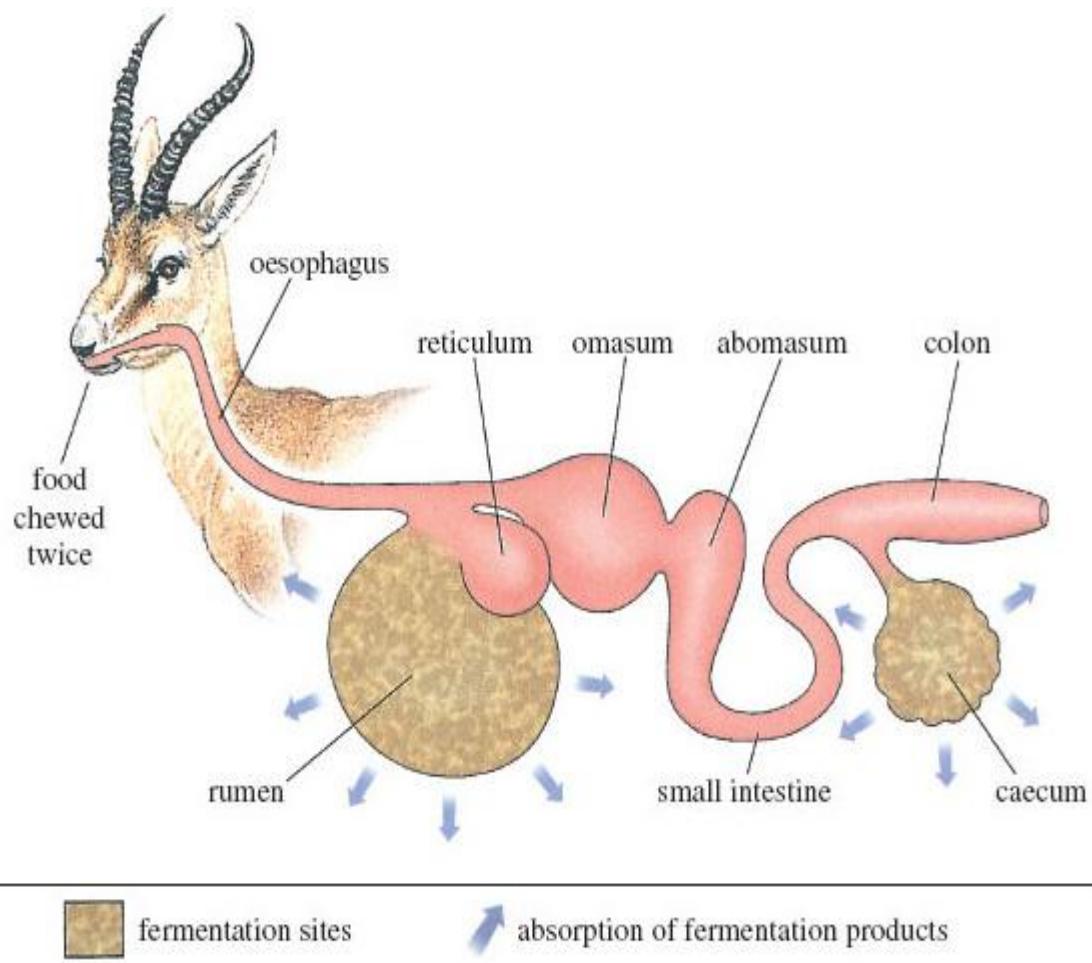
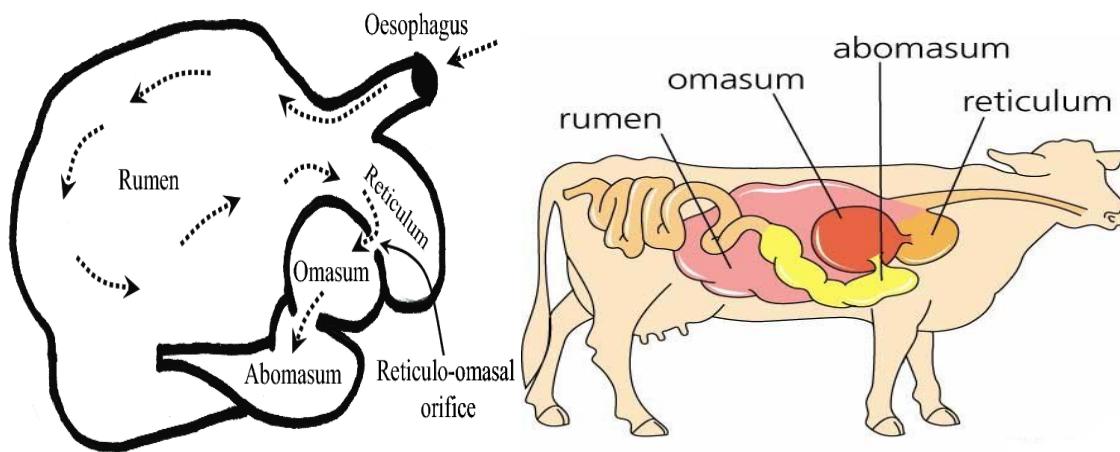
- These are bulk with high mass matter per unit area.

### **CHARACTERISTICS OF SUCCULENT ROUGHAGES**

- They have high moisture content (920-50%).
- They have low dry matter content.
- They have carbohydrate contents and with low protein content.
- They contain carotene which is rich in vitamin A.
- They are main diet of ruminants.

Ruminants are animals with four chambers of stomach. They feed on roughages





### EXAMPLES OF SUCCULENT ROUGHAGES

These include

1. Fresh grass such as star, kikuyu grass, elephant grass, giant star grass, silage, banana stems.

2. Legume pastures which include proteins, for example, Lucerne, Leucaena, desmodium spp, Glycine spp etc.
3. Browsing trees and shrubs which are mainly found in semi-arid areas such as acacia
4. Vegetables such as cabbages and kale.
5. Sweet potato vines and turnips

### **B. DRY ROUGHAGES**

- Dry roughages are also known as course roughages.
- They contain less moisture which is less than 20%.
- They have higher crude fibre content.
- They are prepared from grasses, legumes and other crop residues as hay
- -They have very fibrous, have low energy value and are used to provide bulk feeding in animals.

### **EXAMPLES OF DRY ROUGHAGES**

These include

2. Hay
3. Straws and maize stovers.
4. Groundnut haulms

### **5. CONCENTRATES**

- Concentrates are livestock feeds which have high carbohydrates and protein content but low in crude fibre content which is less than 20%.
- The diets of non-ruminants are usually concentrates because they cannot handle food with higher crude fibre content.

### **TYPES OF CONCENTRATES**

These include

#### **1. ENERGY/CARBOHYDRATE CONCENTRATES**

Energy concentrates are concentrates with high carbohydrate content.

#### **Examples of energy concentrates**

These are

- a. Grains and their by-products such as maize, madeya, wheat meal, sorghum and millet.
- b. Grain legumes and their-product which include groundnuts, groundnut cakes, soya meal, bean and bean meal.
- c. Molasses from sugar.

## **2. PROTEIN CONCENTRATES**

These are concentrates with high protein content

### **EXAMPLES OF PROTEIN CONCENTRATES**

These include

1. Meat
2. Bone meal
3. Fish meal
4. Oil cake from cotton seed
5. Soya bean
6. Sunflower

### **ADDITIVES**

These should be given to animals apart from roughages and concentrates.

Examples of additives include vitamins and mineral supplements.

### **Cattle Feed and Feed Additives**



Functions of additives

- a. To stimulate growth
- b. To improve feed utilization
- c. To control internal parasites.

## **FEED RATION**

A ration is defined as the amount of feed given to the animals every day.

### **BALANCED RATION**

**This refers to the amount of feed that contains all the nutrients and in the right proportions.**

### **TYPES OF RATIONS**

**These include**

#### **1. MAINTENANCE RATION**

This defined as the amount of feed that the animal feeds per day to maintain its body processes such as respiration, movement, blood circulation and body temperature without gaining or losing weight.

#### **2. PRODUCTION RATION**

This is defined as the amount of feed given to the animals over and above maintenance ration. This is essential for animals to produce eggs, milk and meat.

### **FACTORS THAT AFFECT THE CHOICE OF FEEDS TO USE TO FEED ANIMALS**

These include

1. Its availability
2. The cost of the feedstuffs.
3. The nutritional composition.
4. The physical or processing nature of the feedstuff such as colour, smell, particle size.

### **REASONS THAT MAKE FARMERS FAIL TO PROVIDE BALANCED FEEDS TO LIVESTOCK**

- a. High cost of commercially produced
- b. Lack of adequate knowledge.

### **METHODS OF RATION FORMULATION**

The commonly used method of ration formulation is the **Pearson's square method**.

#### **PEARSON'S SQUARE METHOD**

This method can only be used for two feed stuff and to be used requires to have the knowledge of the following

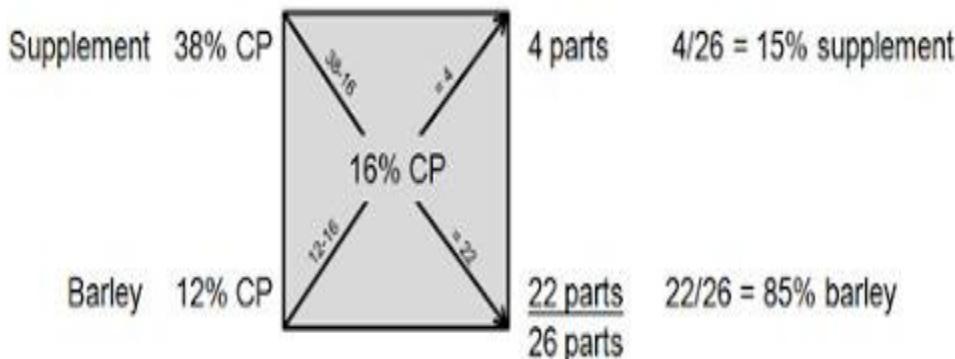
- a. Animals' feed requirement.
- b. Nutrient composition of the ingredients and targets only proteins.

**PROCEDURES TO BE FOLLOWED WHEN USING PEARSON'S SQUARE METHOD WHEN FORMULATING A RATION**

1. Draw a square
2. Place the desired protein percentages in the ration in the middle of the square
3. Draw diagonals of the square.
4. Place the percentages of each stuff at the left corners of the square.
5. Subtract the figures diagonally across the square. Remember to subtract the smaller number from the larger number.
6. Disregard the negative signs.
7. Place the number obtained on the right corners, giving the required parts of each feedstuff to be used in the mixture.
8. Add up the parts to obtain at the base what will be used to calculate the amount of each feedstuff to be used in preparation.

**EXAMPLES**

1. Formulate a cattle ration containing 16% protein using supplement meal containing 38% protein and Barley meal containing 12% protein. Calculate the amount in kilograms of each feedstuff required to prepare 260kg.



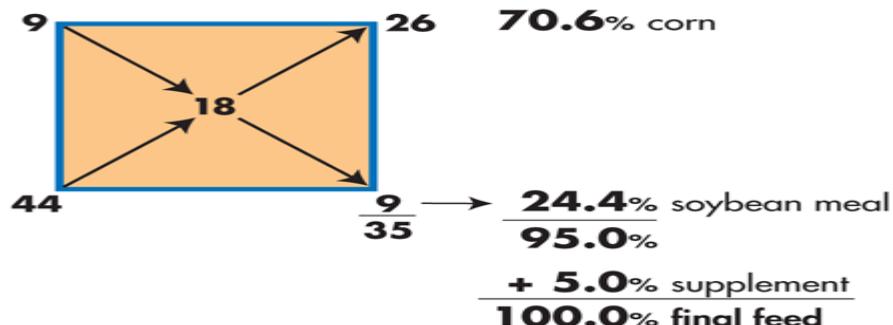
$$\begin{aligned}\text{Supplement Meal} &= \frac{4}{26} \times 260\text{kg} \\ &= 40\text{kg}\end{aligned}$$

$$\begin{aligned}\text{Barley Meal} &= \frac{22}{26} \times 260\text{kg} \\ &= 220\text{kg}\end{aligned}$$

From the calculations above, when 4parts of supplements are mixed with 13 parts of barley meal, the results will be 16% protein ration.

2. Formulate a cattle ration containing 18% protein using corn meal containing 9% protein and soybean meal containing 12% protein. Calculate the amount in kilograms of each feedstuff required to prepare 400kg.

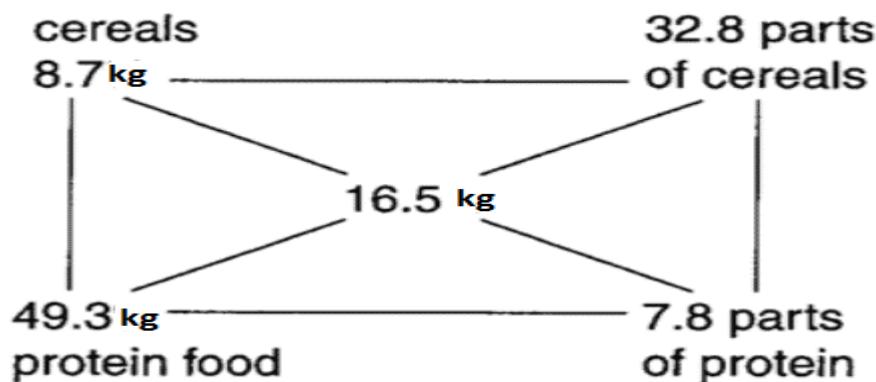
**Formulating feed with the Pearson Square method**



$$\begin{aligned}\text{Corn Meal} &= \frac{70.6}{100} \times 400\text{kg} \\ &= 282.4\text{kg}\end{aligned}$$

$$\begin{aligned}\text{Soybean Meal} &= \frac{24.4}{100} \times 400\text{kg} \\ &= 97.6\text{kg}\end{aligned}$$

3. Formulate a cattle ration containing 16.5kg protein using cereals containing - 8.7kg protein and protein food containing 49.3kg protein. Calculate the amount in kilograms of each feedstuff required to prepare 400kg.



**Total = 32.8 + 7.8 parts**

$$=40.6$$

$$\text{Cereal Meal} = \frac{32.6}{40.6} \times 40600\text{kg}$$

$$= 32,600\text{kg}$$

$$\text{Soybean Meal} = \frac{7.8}{40.6} \times 40600\text{kg}$$

$$= 7,400\text{kg}$$

## **FACTORS TO CONSIDER WHEN FEEDING LIVESTOCK OR WHEN BALANCING FEED RATIONS**

These factors include

### **1. The type of animals**

Ruminants can digest roughages while non ruminants cannot.

### **2. The age and body size of the animal**

Young animals require less feed than larger animals and some animals will initially depends on milk until they are introduced to solid feeds.

### **3. Physiological condition of the animal**

Animals should not be allowed to starve and feed should not be wasted because it is expensive.

### **4. Purpose for which the animal is kept or level of production.**

Draught animals require high energy feeds and animals kept for milk, meat and eggs require more concentrates.

### **5. The quality of the feed**

The feed should be easy to ingest and digest

### **6. Palatability**

The feed should be appetizing to animals.

### **7. Digestibility**

The feed should be easy to digest and this depends on the type of the animal.

### **8. The amount of feed and its texture**

This will depend on quality and type of the feeds. The coarseness and finest is an important aspect especially for chickens.

## **9. Cost of the feed**

Feed should be given to animals which are in production and feed should not be wasted as it is expensive. This also determines the number of animals the farmer is able to keep.

### **THE COMPOSITION OF FEED AND FUNCTIONS OF NUTRIENTS**

<b>Nutrients</b>	<b>Function</b>	<b>Source</b>
Carbohydrates (made up of starches and sugar)	<ul style="list-style-type: none"> <li>• Provide energy</li> <li>• - Excess carbohydrates are stored as fats</li> </ul>	<ul style="list-style-type: none"> <li>• Cereal, (maize sorghum, millet)</li> <li>• Potatoes and their vines Grass</li> <li>• Root tuber</li> </ul>
Fats and oils	<ul style="list-style-type: none"> <li>• Provide energy twice as much energy as carbohydrates</li> </ul>	<ul style="list-style-type: none"> <li>• Oil seeds (e.g. groundnuts)</li> <li>• Soya, milk, eggs, meat, fish meal</li> </ul>
Proteins (made of proteins)	<ul style="list-style-type: none"> <li>• Body building and repair</li> <li>• Component of enzyme hormones, antibodies</li> <li>• Excess proteins are converted into proteins, carbohydrates or glycogen</li> </ul>	<ul style="list-style-type: none"> <li>• Grains, legumes eg beans, ground nuts</li> <li>• Meat, liver, milk</li> <li>• Bone and fish meal</li> </ul>
Minerals calcium and phosphorus	<ul style="list-style-type: none"> <li>• Bone formation</li> <li>• For milk production</li> <li>• Egg shell formation</li> </ul>	<ul style="list-style-type: none"> <li>• Meat, milk, lime bone meal</li> </ul>
Magnesium	<ul style="list-style-type: none"> <li>• For health bones and teeth</li> <li>• Help to metabolise carbohydrates</li> </ul>	<ul style="list-style-type: none"> <li>• Milk, cereal grains, leafy vegetables</li> </ul>
Iron	<ul style="list-style-type: none"> <li>• Part of haemoglobin</li> <li>• Prevents anaemia</li> </ul>	<ul style="list-style-type: none"> <li>• Egg yolk</li> </ul>
Iodine	<ul style="list-style-type: none"> <li>• Essential for the growth of thyroid gland which produces thyroxine</li> <li>• Prevent goitre</li> </ul>	<ul style="list-style-type: none"> <li>• Iodised salt</li> </ul>
Copper and cobalt	<ul style="list-style-type: none"> <li>• Form part of haemoglobin and enzymes (cobalt) is part</li> </ul>	<ul style="list-style-type: none"> <li>• Salt containing copper and cobalt</li> </ul>

	<ul style="list-style-type: none"> <li>• of vitamin B12</li> <li>• Improve appetite in ruminants</li> <li>• Prevents anaemia</li> <li>• Maintains blood pressure</li> <li>• Essential for bile formation</li> </ul>	<ul style="list-style-type: none"> <li>• Most vegetables contain copper and cobalt</li> </ul>
Sodium	<ul style="list-style-type: none"> <li>• Maintain blood pressure</li> <li>• For bile formation</li> </ul>	<ul style="list-style-type: none"> <li>• Common salt and rock salt</li> </ul>
Manganese	<ul style="list-style-type: none"> <li>• Helps in bone formation and enzymatic reactions.</li> <li>• For metabolism of proteins and carbohydrates</li> </ul>	<ul style="list-style-type: none"> <li>• Most foods</li> </ul>
Chlorine	<ul style="list-style-type: none"> <li>• Part of gastric juice</li> <li>• Aids in digestion</li> </ul>	<ul style="list-style-type: none"> <li>• Common salt and rock salt</li> </ul>
Potassium	<ul style="list-style-type: none"> <li>• Helps in functioning of the muscles and heart</li> <li>• Activates enzymes</li> </ul>	<ul style="list-style-type: none"> <li>• Potassium</li> <li>• Grass</li> </ul>
Zinc	<ul style="list-style-type: none"> <li>• Helps in enzymatic reaction</li> </ul>	<ul style="list-style-type: none"> <li>• Most feeds</li> </ul>
Vitamin A (soluble in fat)	<ul style="list-style-type: none"> <li>• Needed for good eye sight and growth</li> <li>• For prevention of diseases</li> </ul>	<ul style="list-style-type: none"> <li>• Milk, fresh grass, yellow maize, fish cold liver.</li> </ul>
Vitamin B (water soluble)	<ul style="list-style-type: none"> <li>• Helps in metabolism of carbohydrates, proteins and (Water soluble) fats</li> </ul>	<ul style="list-style-type: none"> <li>• Green vegetables</li> <li>• G/nut meal</li> <li>• Cereals ruminants are able to</li> <li>• synthesize vitamin B through the micro organism that is found in therumen.</li> </ul>
Vitamin C (water soluble)	<ul style="list-style-type: none"> <li>• Important for disease resistance</li> </ul>	<ul style="list-style-type: none"> <li>• Green leafy vegetables</li> <li>• Fruits</li> </ul>
Vitamin D	<ul style="list-style-type: none"> <li>• For bone formation</li> <li>• - Prevents rickets in animals</li> </ul>	<ul style="list-style-type: none"> <li>• Sunlight, hay,</li> <li>• - Fish liver oil yeast green grass</li> </ul>
Vitamin E	<ul style="list-style-type: none"> <li>• For proper functioning of the reproductive system</li> </ul>	<ul style="list-style-type: none"> <li>• Grains, soya, grass green vegetables</li> </ul>

	<ul style="list-style-type: none"> <li>• - Prevent sterility</li> </ul>	
Vitamin K - Fat soluble	<ul style="list-style-type: none"> <li>• For blood clotting, prevent breeding</li> </ul>	
Water	<ul style="list-style-type: none"> <li>• For body fluids and maintenance of shape of body, help transport of nutrients.</li> <li>• Helps transport nutrients.</li> </ul>	<ul style="list-style-type: none"> <li>• All feed, especially succulent leafy vegetables or roughages.</li> <li>• Drinking water</li> <li>• All feeds especially succulent feeds</li> </ul>

## **CHAPTER 13: SHEEP AND GOAT PRODUCTION**

### **THE REASONS WHY SHEEP PRODUCTION IS LOW**

1. Lack of improved breeding stock
2. Poor husbandry practices
3. Presence of parasites and diseases.

### **BREEDS OF SHEEP**

#### **The following are breeds of sheep found in Malawi**

##### **1. Local sheep**

It is originated from Malawi.

It is use to provide meat.

##### **2. Dorper**

It is originated from Persia. It provides Mutton to the farmers.

##### **3. Hampshire**

It is originated from England. It provides Mutton the farmers.

##### **4. Merino**

It is originated from North Coast of Africa. It provides Wool to the farmers.

##### **5. Karakul**

It is originated from USSR, Iran and Iraq. It provides Skin to the farmers.

##### **6. Black Head**

It is originated from Persia. It provides Mutton to the farmers.

### **7. Ramsey Marsh**

It is originated from Romney in England. It provides Wool to the farmers.

### **8. Corriedale**

It is originated from New Zealand. It has dual purposes.

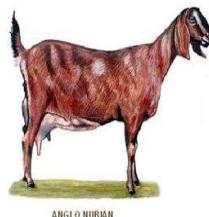
#### **BREEDS OF GOAT**



### **1. Local goat**

It is originated from Malawi. It provides meat to the farmers.

### **2. Anglo-Nubian**



This originated from South Africa

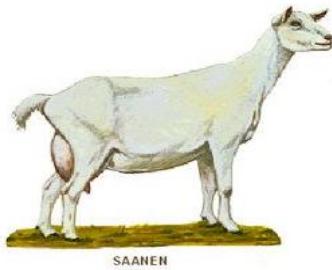
It is used to provide meat

### **Alpine**



It is originated from India. It is used to provide meat to the farmers..

### **3. Saanen**



It is originated from Switzerland. It provides milk to the farmers.

#### **4. Toggenburg**



It is originated from Asia. It provides meat to the farmers.

#### **5. Angola**

It is originated from Britain and its function is to Meat to the farmers

#### **6. Jamnapari**

It is originated from East Africa. It provides meat to the farmers.

#### **7. Small African Goat**

It is originated from East Africa. It provides meat to the farmers.

### **CRITERIA USED FOR SELECTING BREED OF SHEEP**

#### **1. Climate**

- The indigenous sheep are suited to the heat, dry condition of the country.
- The sheep are hardy and adaptable to conditions of low inputs. Local can be improved through cross-breeding and improved management.
- The Karakul is adapted to desert conditions, the Merino thrives well in dry conditions and black persist is hardy.

- The indigenous sheep breeds have more resistance to parasites than the exotic sheep but drenching is very important part of sheep management.
- Availability of feed. Sheep are managed best when they are kept in well fenced paddocks.

**2. Use**

- Select a breed that will give you the highest production of Mutton, Wool or Skin.
- Local Malawian Sheep produces reasonable amount of Mutton, weighing up to 30kg but can be crossed with exotic breed to improve mutton, wool and skin production.
- The Black Persian sheep is good for mutton. It can weigh up to 50kg but its fat distribution is uneven. It can cross breed with Dorset Ram to improve this breed.
- Merino sheep are famous for wool production.
- Karakul sheep are good for skin or pelt production.

**THE CHARACTERISTICS OF MUTTON SHEEP**

They have the following characteristics

1. Good mothering ability of ewes
2. Should be fast growing.
3. Should have large body weight/size.
4. High quality mutton produced.

**FACTORS TO CONSIDER WHEN SELECTING APPROPRIATE BREEDS OF GOATS**

1. The purpose for which they are kept, meat or mohair.

The following are the characteristics of goats kept for meat production

- a. Grow fast and mature early
- b. Be from nannies with good mothering abilities.
- c. Have a good body shape.
- d. Milk goats should have large well-developed udders.

**2. Suitable to local and economic environments.**

- The Malawian goats are hardy and disease resistant. It is god scavenger; however its genetic potential is limited. This can be cross-bred with exotic breeds to improve meat and milk production.

### **3. Personal preference**

- Most Malawians consider local goat meat to be tender and tasty but there is no evidence to prove this claim.

## **THE AGE AT PUBERTY FOR SHEEP AND GOATS**

- Puberty is the stage in the life of animals when it is sexually mature to start reproducing.
- Male animal starts producing male gametes known as **sperms** while female animal graffian follicles matures and start releasing female gametes called the **ova/eggs**
- The sheep reaches puberty at age of 15-18 months while goats reach puberty when it is 18 months old.

NB: The mature female sheep which had more than one lamb is called the ewe,

**Ram or Tup** is a mature male sheep

**Wether** is a young female sheep

**Hogget** is a young female sheep

**Lambs** are very young sheep

**Billy/bucks** are a mature male goat.

**Nanny/doe is** a mature female goats which has and more than one kid

**Kid** is a young goat.

## **BREEDING**

- Ewes can first be served (mated) at 18 months old but 2 years is best.
- Rams can mate first at 8 months old.
- Breeding ratio (sex ratio) is: 1 ram for 10 - 20 ewes but a ram can service up to 60 ewes. - **Castrate** rams not required for breeding.
- Castration: is the removal or destruction of male reproductive organs.

## **REASONS FOR CASTRATION**

- Animal fatten quickly
- Prevents inheritance of undesirable genes.
- Animal become more docile, so easier to handle
- Reducing fighting and so injuries
- May check spread of sexually transmitted diseases.

## **METHODS OF CASTRATION**

### **A) OPEN METHOD**

- Using a sharp knife to cut open scrotum and remove the testicles or cut and tie sperm ducts.

### **B) CLOSED METHOD**

- **Burdizzo** is used to crush the testis or spermatic cords
- **Elastrator** or strong rubber band is tied round the testes and above the testes to cut off blood supply to them. The scrotum and testes drop off after a few weeks.
- Mate animals in November so that lambing (five months later) takes place when grass is in plentiful.

## **OESTRUS CYCLE/HEAT PERIOD**

- **Oestrus cycle** is defined as the recurring period of receptivity in female mammals.
- In sheep, heat period first occurs when the sheep is around six to ten months.
- The oestrus cycle is between fifteen and nineteen days and last for 18-24 hours in sheep.
- In goats, oestrus cycle is 18 to 21 days.

## **BREEDING**

- The best time to mate animals is 5 months before the rains start so that animals will bear young kids or lambs when there is plenty food.

## **FLUSHING**

- Flushing is the practice of giving concentrates to sheep two weeks before mating to improve health and fertility.

### **STEAMING**

- **Steam up** ewes two months before lambing. This ensures better development of foetus and smooth lambing. **Steaming** is feeding quality feed (cereal, grains or oil cakes, good silage or hay) to pregnant animals prior to giving birth.

### **KIDDING/LAMBING**

Kidding is the process of giving birth in goats while lambing is the process of giving birth in sheep.

#### **Explain five signs of heat in an ewe (sheep).**

An ewe on heat will show the following signs

1. Seeks out for rams.
2. Stands to be mounted.
3. Rapid tail movement or raised tail in the presence of a ram.
4. Nervousness.
5. Increased vocalizations.
6. Decreased in appetite
7. Reddened and swollen vulva.

#### **Give five signs of heat in nanny (goat).**

A nanny on heat will show the following signs

1. restlessness
2. Mounting others and stands still to be mounted.
3. It seeks out for males.
4. Constant vocalizations.
5. Loss of appetite.
6. Rubbing up against herd-mates.
7. Redness and swelling around the vulva.
8. Thin clear mucous discharge from the vulva.
9. The nanny frequently wags or twitches or her tail
10. Shows signs excitement

Vulva become red and thick

### THE FOLLOWING ARE SIGNS HEAT PERIOD IN GOATS

- The nanny frequently wags or twitches or her tail
- Shows signs excitement
- Sometimes mounts other nannies
- Vulva become red and thick
- Mucus discharge from the vulva

### GESTATION PERIOD

- Refers to period between fertilization and kidding or lambing.
- Its 5 months or 150 days in both goats and sheep
- During this period the animals should be well looked after and should be regularly be drenched or dosed against internal parasites and vaccinated against disease.
- They should be given concentrates one to two months before lambing or kidding and this is called **steaming up**.

### CHARACTERISTICS OF GOOD SHEEP HOUSE



- Spacious
- Strongly built because sheep are prone to predators.
- Well ventilated to prevent spread of disease.
- Well lit.
- Dry and easy to clean
- Easy and cheap to construct

### CHARACTERISTICS OF GOOD GOAT HOUSE

## SIMPLE GOAT SHED DESIGN



1. It is sited on a high ground



2. It is cheap to construct
3. It is strongly built
4. It is roomy - with a floor space of about 1.0m<sup>2</sup>
5. It is well lit
6. It is well ventilated, drought -free and dry.
7. It has hard floor made of concrete or hardened /rammed earth or clay.
8. It has well thatched roof
9. It is well drained and easy to clean.

### FEEDING BEHAVIOURS OF GOATS

- Sheep and goats are ruminants that depend mostly on pasture or grass.
- Ruminant animals are animals with four chambers of stomach. Examples include cattle, goats etc.
- Sheep are more grazers than browser.
- While goats are both grazers and browsers.

### **GOAT BROWSING**

In browsing, the animal eats any parts of the plants. Goats will therefore eat plant leaves, stems and even roots. They eat barks, of stems. Goats can end up destroying trees to point of death causing deforestation. This is why they are called browsers.



### **GRAZING**

- In grazing, animal will eat grass and or herbs. Where possible, grazing animals can eat selectively, eating only the most palatable plant species.
- In grazing correct stocking rate prevents pasture destruction. Browsers can destroy trees when grass and edible herbs are readily available.
- The diagram below shows goat grazing



### **DOCKING**

- Docking is the process of cutting tail of an animal.
- In lambs docking is when it is four or five weeks old.
- The tails are cut about 5cm from the body.



### **REASONS FOR DOCKING**

1. It prevents dirt and dung from collecting under the tail which could otherwise be a source of infection.
2. It helps in parasite control. For example, it is easier to remove external parasites such as ticks from the anal area.
3. It helps improve the quality of the carcass in fat tailed sheep.
4. It helps the animal to mate easily.

### **BRANDING**

- It is a process of placing identification marks on the body of an animal.
- It is important because it enables the farmer to easily identify the animals when handling them.

### **SUITABLE FEEDS FOR SHEEP AND GOATS**

#### **1. Forage plants**

These include grass, legumes such as Lucerne, and shrubs and trees whose leaves are browsed.

#### **2. Roughages**

These include mature pastures such as dry forage and residues from crops such as straw and haulms.

#### **3. Roots**

These include cassava, sweet potatoes and yams.

#### **4. Concentrates**

These include

- a. Protein concentrates of plant origin, for example, groundnuts, cotton seed, sesame, soya beans, sunflower and coconut.
- b. Protein concentrates of animal origin are by products from processing of carcasses.

### **REASONS FOR SELECTING SHEEP AND GOATS FEEDS**

1. They provide a balanced ration
2. They are locally available since they are made
3. Some can be bought cheaply
4. Some can be grown on the farm.
5. They are free from toxic substances.
6. They can be dried and stored for use during the dry season.
7. They contain a lot of nutrients.

### **WHAT ARE THE SYSTEMS FOR MANAGING GOATS AND SHEEPS?**

These include

#### **1. EXTENSIVE SYSTEM**

Animals are kept freely during the day to graze and browse. Sometimes they are supervised by herders.

#### **2. TETHERING**

Animals are tied to a tree during the day.

### **WHAT ARE THE TYPES OF TETHERINHG?**

These include

#### **1. PICKET**

The animals are tied by collar and chain to stake driven into ground.

#### **2. RUNNING TETHERING**

Animals are chained to metallic pipe fixed on the ground horizontally.

#### **3. SEMI-INTENSIVE**

Animals are housed at night and fenced in paddocks at least 2 hectares during day. Clean water should be provided to the goats.

#### **4. INTENSIVE SYSTEM**

This is also known as zero grazing or stalls feeding or cut and carry. Under this system, goats are kept in the house and feed is brought to them.

### DISEASES OF SHEEP AND GOATS

These include

#### 1. NASA WORM

It is caused by **Nasal bot (worm) fly**

##### **Signs and symptoms**

- a. Small grey-greening fly with prominent black spots on thorax-fly covered with short light brown hairs.
- b. Sneezing and thick nasal discharge.

##### **Treatment and control measures**

- a. Spraying or dipping
- b. Use a fly repellent like Stockholm tar to repel flies off seed.

#### 2. FOOT AND MOUTH

It is caused by **virus**.

##### **Signs and Symptoms**

- a. High fever
- b. Inflammation of tongue, lips and gums making it difficult to eat.
- c. Lameness
- d. Profuse and continuous salivation

##### **Treatment and control measures**

- a. Imposition of quarantine
- b. Vaccination every six months
- c. Slaughter, burn and bury infected animals.
- d. Disinfect animals' hooves

#### 3. MASTITIS

It is caused by **bacteria**.

##### **Signs and symptoms**

- a. Blood clots or pus in milk.

- b. Swollen udder.
- c. Drop in milk yield
- d. Rise in body temperature

**Treatment and control measures**

- 1. Practice hygiene during milking
- 2. Treat with antibiotics
- 3. Use disinfectants
- 4. Vaccination.

**4. BRUCELLOSIS**

It is caused by **bacteria**

**Signs and symptoms**

- a. Abortion in late gestation
- b. Retention of placenta
- c. Yellow, brown , slimy discharge from the vulva may occur

**Treatment and control measures**

- a. Cull and slaughter infected animals.
- b. Disinfect areas contaminated with uterine discharges.
- c. Use of artificial insemination.
- d. A blood test for all breeding herds to detect infected animals.

**5. PNEUMONIA**

It is caused by **bacteria**

**Signs and symptoms**

- a. Severe respiratory problems
- b. Abnormal lung sounds such as bubbling, hissing and gurgling
- c. Animal appears dull and loses appetite.

**Treatment and control measures**

- a. Keep young animals in warm house.
- b. Treat early cases of the diseases with antibiotics
- c. Isolate sick animals.

d. Ensure proper ventilation in the animals' houses.

## **6. SHEEP POX**

It is caused by **virus**.

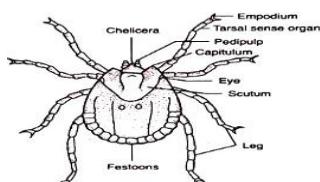
### **Signs and symptoms**

- a. High fever
- b. Dark and red pimple/lesions
- c. Some lambs die
- d. Abundant mucoid nasal discharge.

## **EXTERNAL PARASITES OF SHEEP AND GOATS**

These include

### **1. TICKS**



### **TYPES OF TICKS**

These include



Soft ticks  
Argasidae



Hard ticks  
Ixodidae

#### **a. Soft ticks**

- They have a tough leathery outer coating

#### **b. Hard ticks**

- They have a hard, shield-like covering at the upper surface in males.

The females have a small area behind the head.

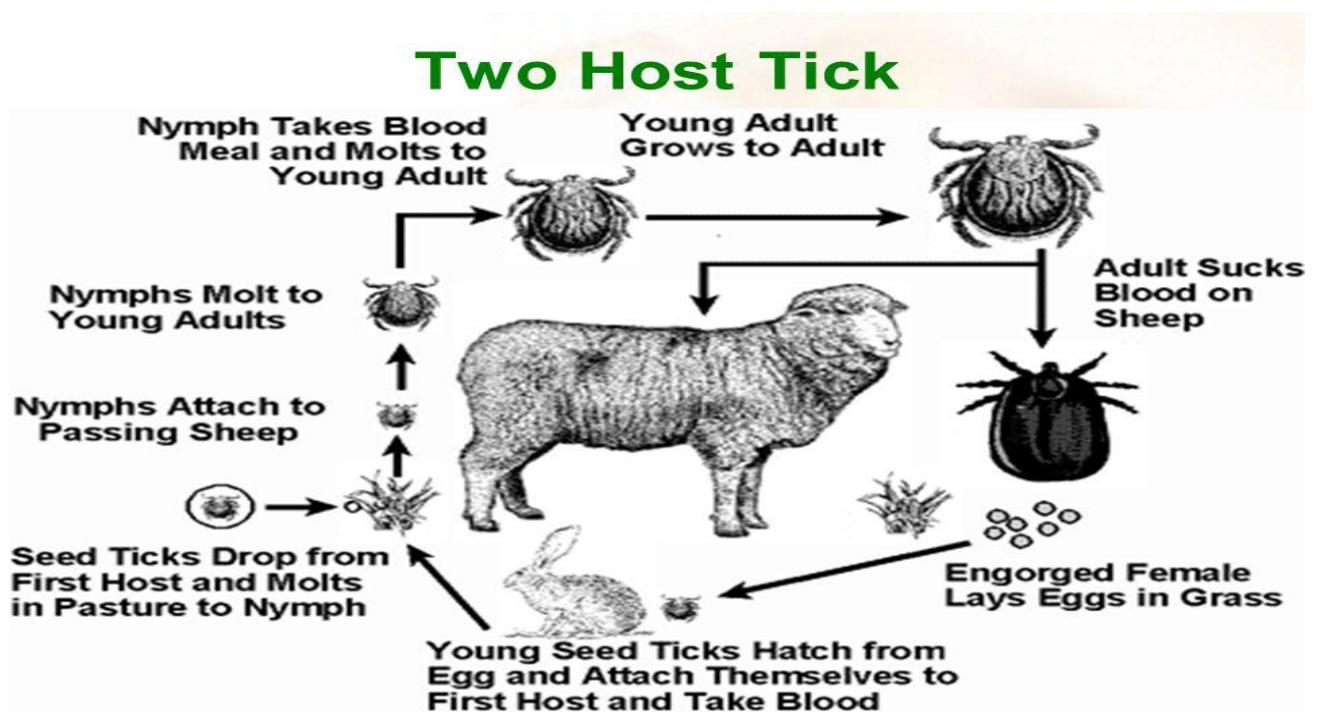
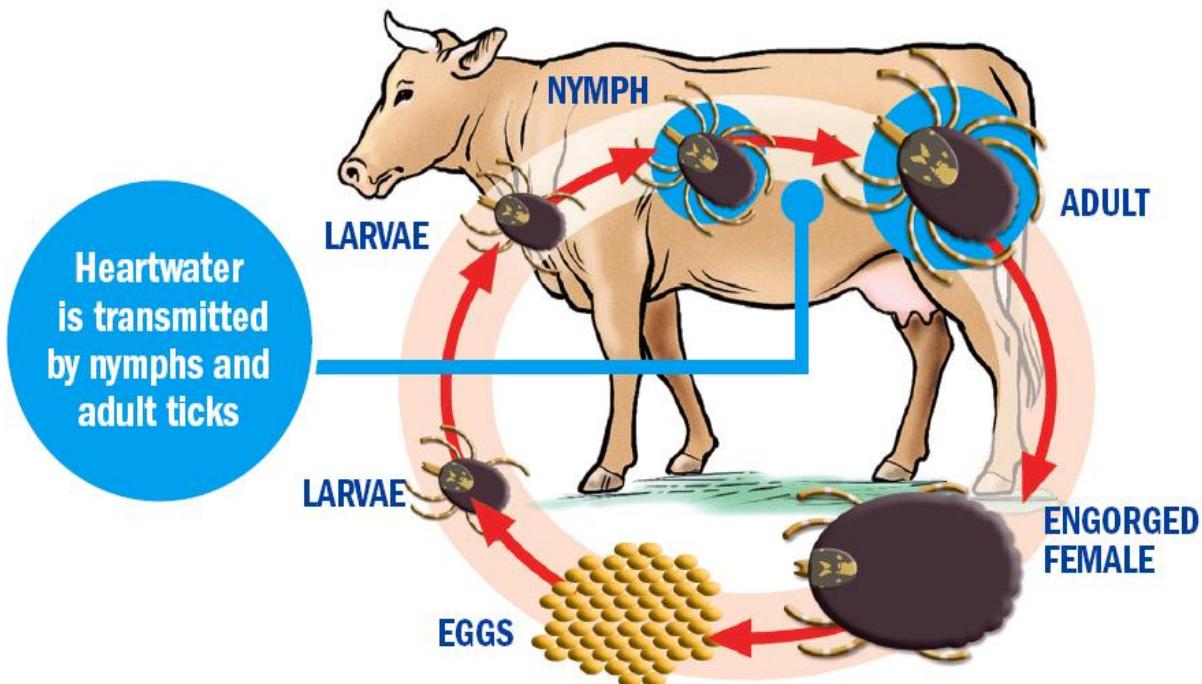
Male



Female



- Ticks attack ears, tail and udder.
- Suck blood thereby causing anaemia
- Transmit diseases such as heart water and red water



### **Treatment and control**

#### **a. Hand dressing**

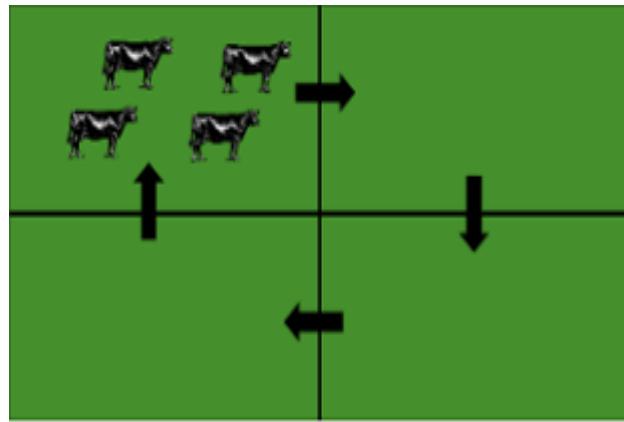
This involves the application of chemicals known as acaricides by hand where spraywash may not reach that is in the inner grooves of ears by use of pyegrease.

#### **b. Fencing**

This involves enclosing the farm by a fence which restricts movement of animals thus minimizing the spread of ticks. Double fencing and use of zero grazing units ensure effective tick control.

#### **c. Rotational grazing**

This reduces the build-up of ticks in pasture.



#### **d. Burning of infected pasture**

This method destroys adult ticks, their eggs, moulting larvae and the nymphs in range lands. Burning the infected pasture can kill and destroy life cycle of ticks

#### **e. Ploughing the land**

This method buries ticks deeply on the ground thus rendering them unable to live. Ploughing the land buries ticks into the ground.

## **2. SCALY MITES**

They attack skin and cause itching.

### **Treatment and control measures**

- Dipping
- Spraying

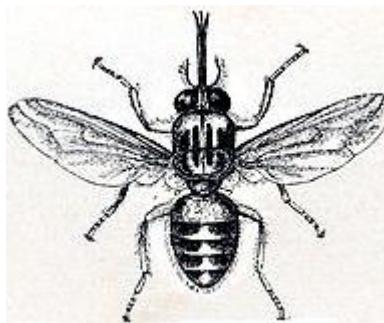
### 3. LICE

They attack skin, head, foot and suck blood.

#### Treatment and control measure

- Dipping

### 4. TSETSE FLIES



- They are found in humid and bushy areas.
- They become active during the day
- They transmit trypanosomiasis/nagana in livestock.

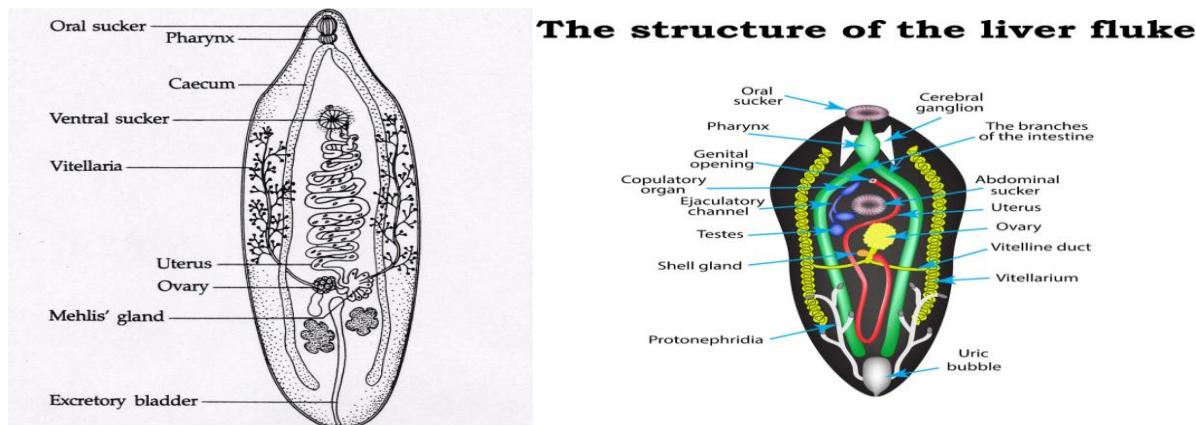
#### Treatment and control measures

- Spraying
- Sterilization of the male tsetse flies by use of chemicals.
- Clearing bushes in areas infested by Tsetse flies.
- Trapping of flies by using special nets treated with appropriate chemicals.

### INTERNAL PARASITES/ENDOPARASITES OF SHEEP AND GOATS

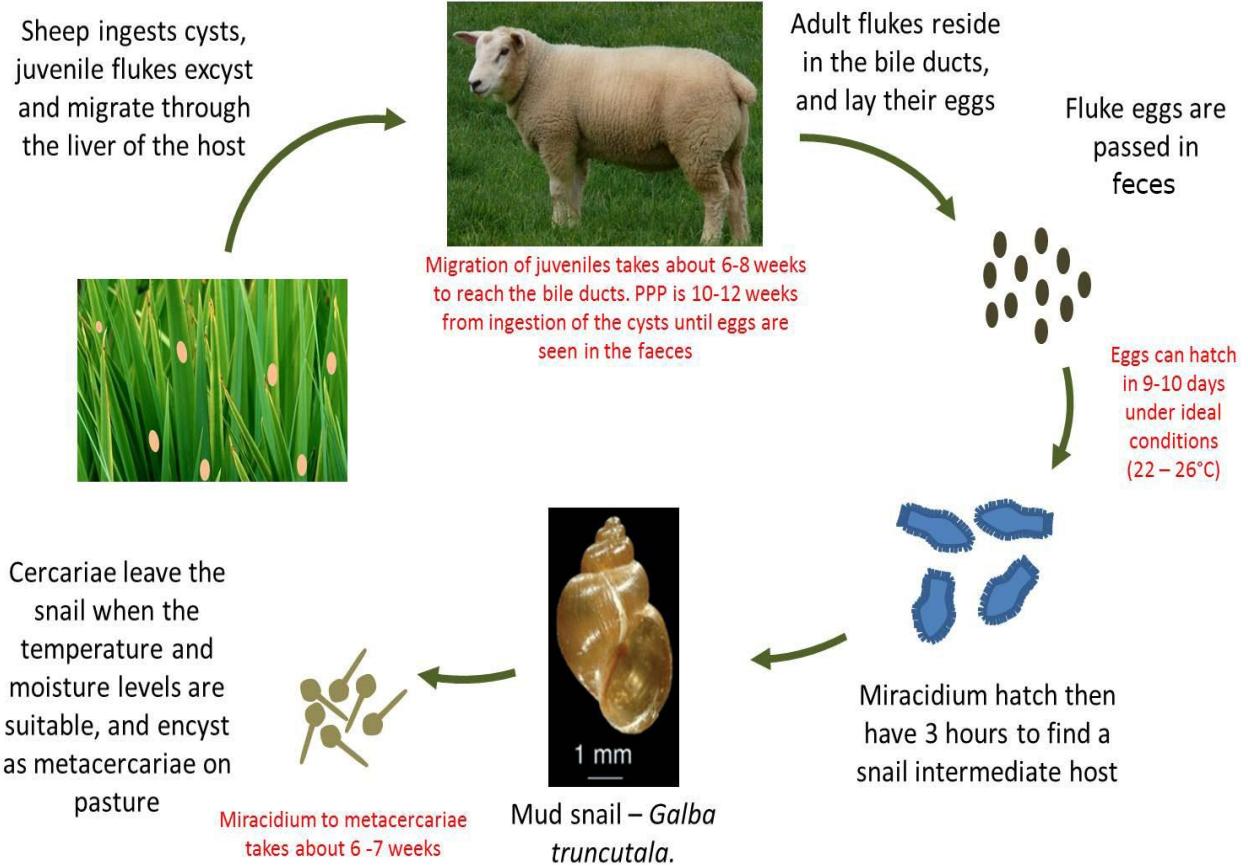
These include

#### 1. LIVERFLUKE



- Liverfluke inhibit bile duct of sheep and goats
- They cause damage to the liver.

### LIFE CYCLE OF LIVERFLUKES



### EFFECTS OF LIVERFLUKE ON GOATS AND SHEEP

- Digestive upset due to blockage of bile duct.
- Swollen abdomen
- Demaciation (loss of body weight)
- Oedema in jaws (swelling)
- Death due to severe demaciation

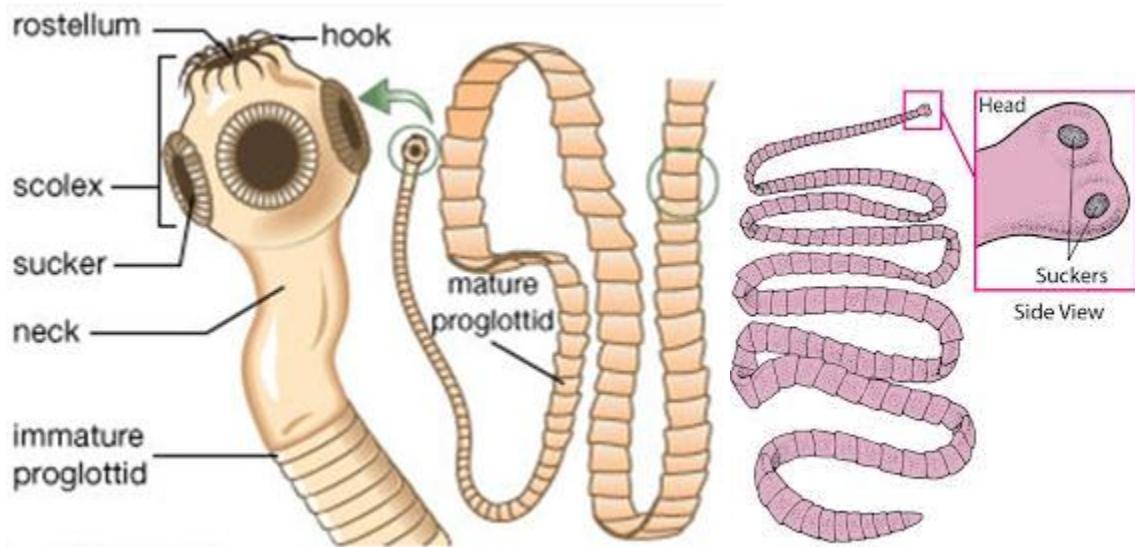
### CONTROL MEASURES OF LIVERFLUKES

- Routine drenching using drugs.
- Destroy water snails by treating swampy water with copper sulphate

- c. Fencing of heavily infested areas to prevent farm animals from grazing in such infected areas
- d. Draining swampy areas within the farm.

## 2. TAPEWORMS

A tapeworm consists of a head called (**scolex**) and a chain of body segments referred to as **strobila**. The scolex possesses suckers and hooks for attachment onto the host. The two most common tapeworm species that affect livestock are



a. **Taenia saginata**

b. **Taenia solium**

### SIGNS OF TAPEWORM ATTACK

- Rough hair coat
- Digestive disturbances such as diarrhea and occasional constipation
- Pot belly
- Anaemia
- Oedema
- Egg segments or proglottids in the faeces

### CONTROL MEASURES OF TAPEWORMS

- Routinely deworm animals using appropriate drugs such as nilzan, albendazole and mebendazole.
- Plough the pasture land to kill the cysts

- Proper disposal of human waste through proper use of latrines
- Proper cooking meat
- Proper meant inspection.
- Drenching the animals
- Rotational grazing so that the eggs cannot be picked by the susceptible host.

### **3. ROUND WORMS**

- These are usually cylindrical in shape and pink or white in colour. They exist as male and female.
- Roundworms inhabit the alimentary canal of cattle.

#### **SIGNS OF ROUNDWORMS ATTACK**

- Retarded growth
- Scours
- Anaemia
- Pot belly

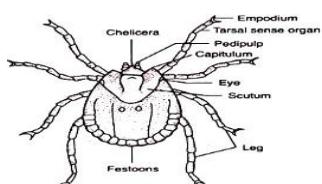
#### **CONTROL MEASURES OF ROUNDWORM ATTACK**

- Avoid grazing animals on muddy grounds
- Avoid grazing animals on wet grass early in the morning when the larvae are active.
- Deworm the animals using drenching with phenothiazine.
- Low stocking rate of animals
- Rotational grazing helps to reduce rate of infection as low populations of the worms can be resisted animals.

### **EXTERNAL PARASITES OF SHEEP AND GOATS**

These include

#### **5. TICKS**



## TYPES OF TICKS

These include



### c. Soft ticks

- They have a tough leathery outer coating

### d. Hard ticks

- They have a hard, shield-like covering at the upper surface in males.

The females have a small area behind the head.

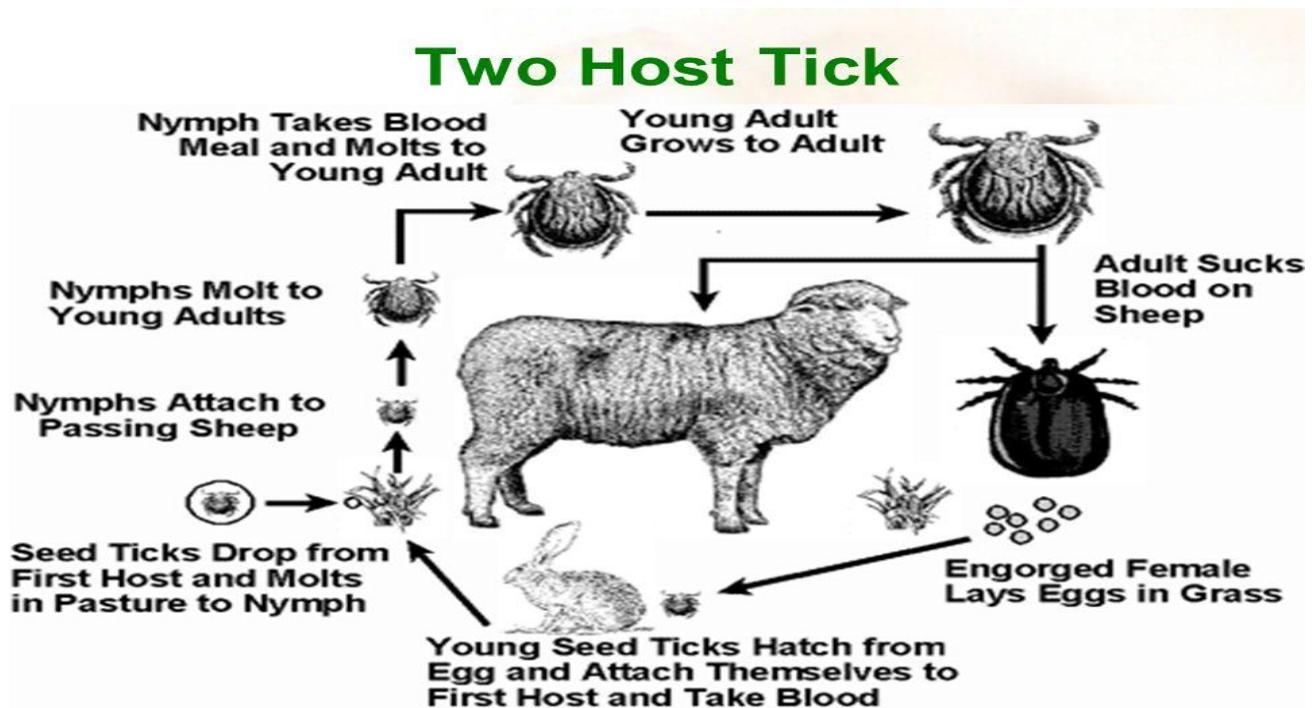
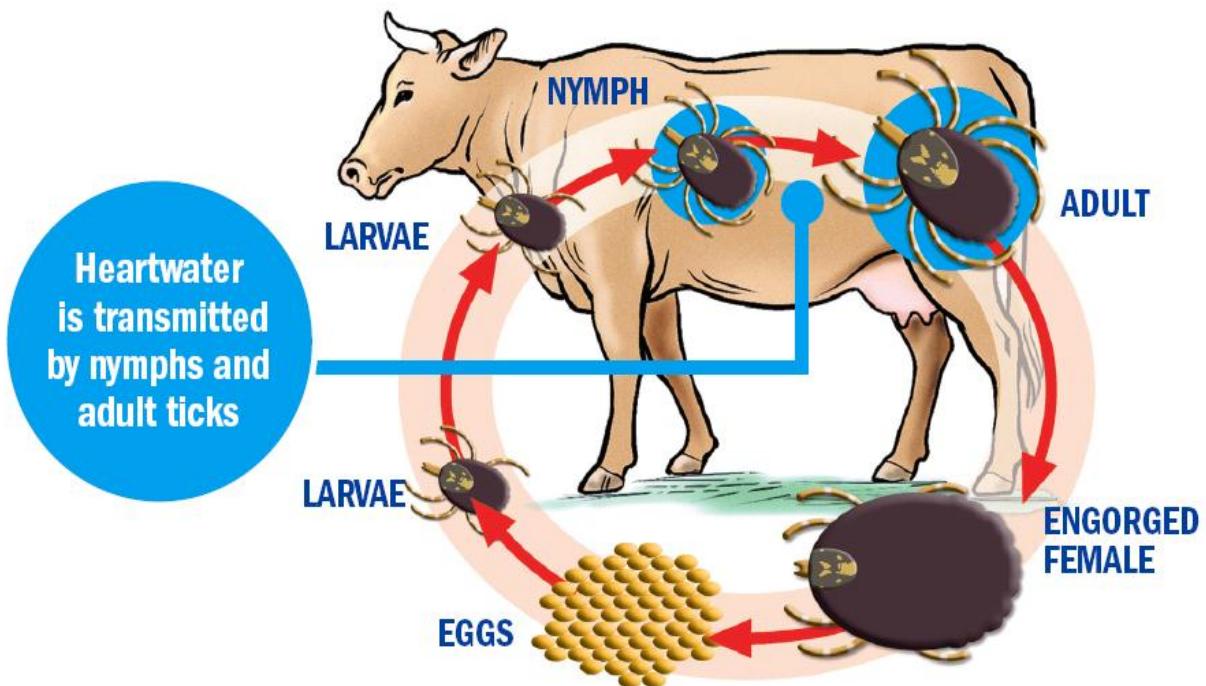
Male



Female



- Ticks attack ears, tail and udder.
- Suck blood thereby causing anaemia
- Transmit diseases such as heart water and red water



#### Treatment and control

- Hand dressing

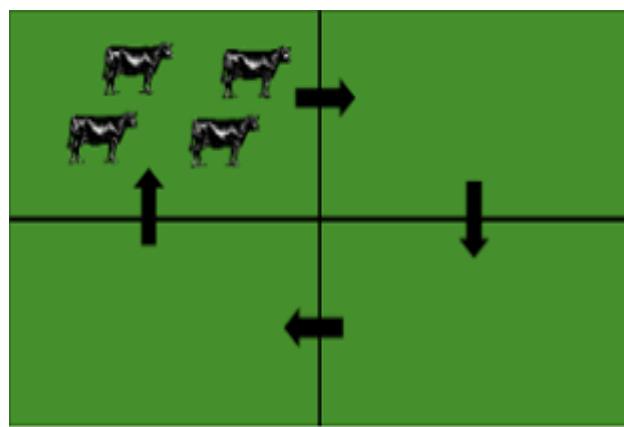
This involves the application of chemicals known as acaricides by hand where spraywash may not reach that is in the inner grooves of ears by use of pyegrease.

**g. Fencing**

This involves enclosing the farm by a fence which restricts movement of animals thus minimizing the spread of ticks. Double fencing and use of zero grazing units ensure effective tick control.

**h. Rotational grazing**

This reduces the build-up of ticks in pasture.



**i. Burning of infected pasture**

This method destroys adult ticks, their eggs, moulting larvae and the nymphs in range lands. Burning the infected pasture can kill and destroy life cycle of ticks

**j. Ploughing the land**

This method buries ticks deeply on the ground thus rendering them unable to live. Ploughing the land buries ticks into the ground.

**6. SCALY MITES**

They attack skin and cause itching.

**Treatment and control measures**

- c. Dipping
- d. Spraying

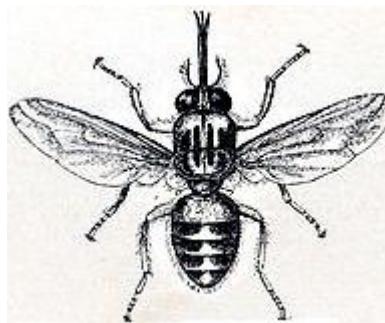
**7. LICE**

They attack skin, head, foot and suck blood.

### Treatment and control measure

- b. Dipping

## 8. TSETSE FLIES



- They are found in humid and bushy areas.
- They become active during the day
- They transmit trypanosomiasis/nagana in livestock.

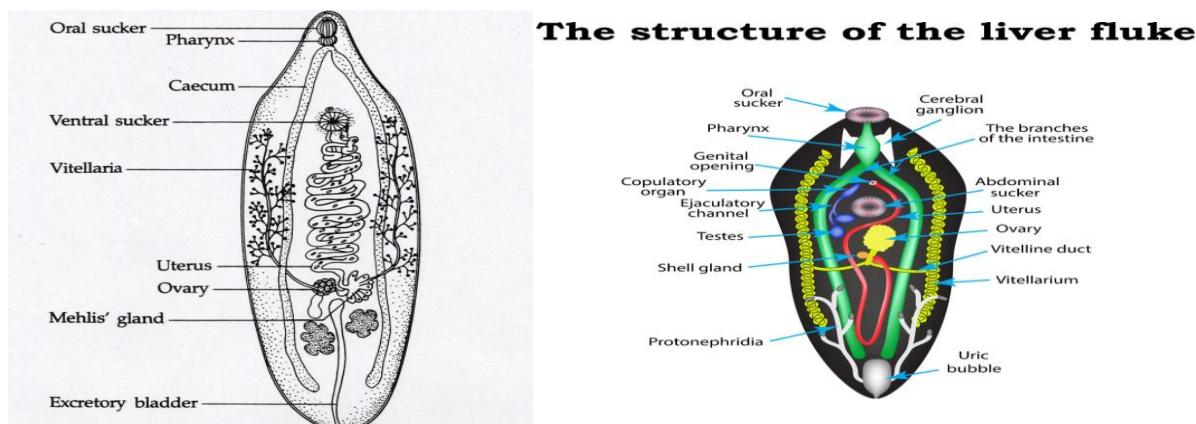
### Treatment and control measures

- e. Spraying
- f. Sterilization of the male tsetse flies by use of chemicals.
- g. Clearing bushes in areas infested by Tsetse flies.
- h. Trapping of flies by using special nets treated with appropriate chemicals.

## INTERNAL PARASITES/ENDOPARASITES OF SHEEP AND GOATS

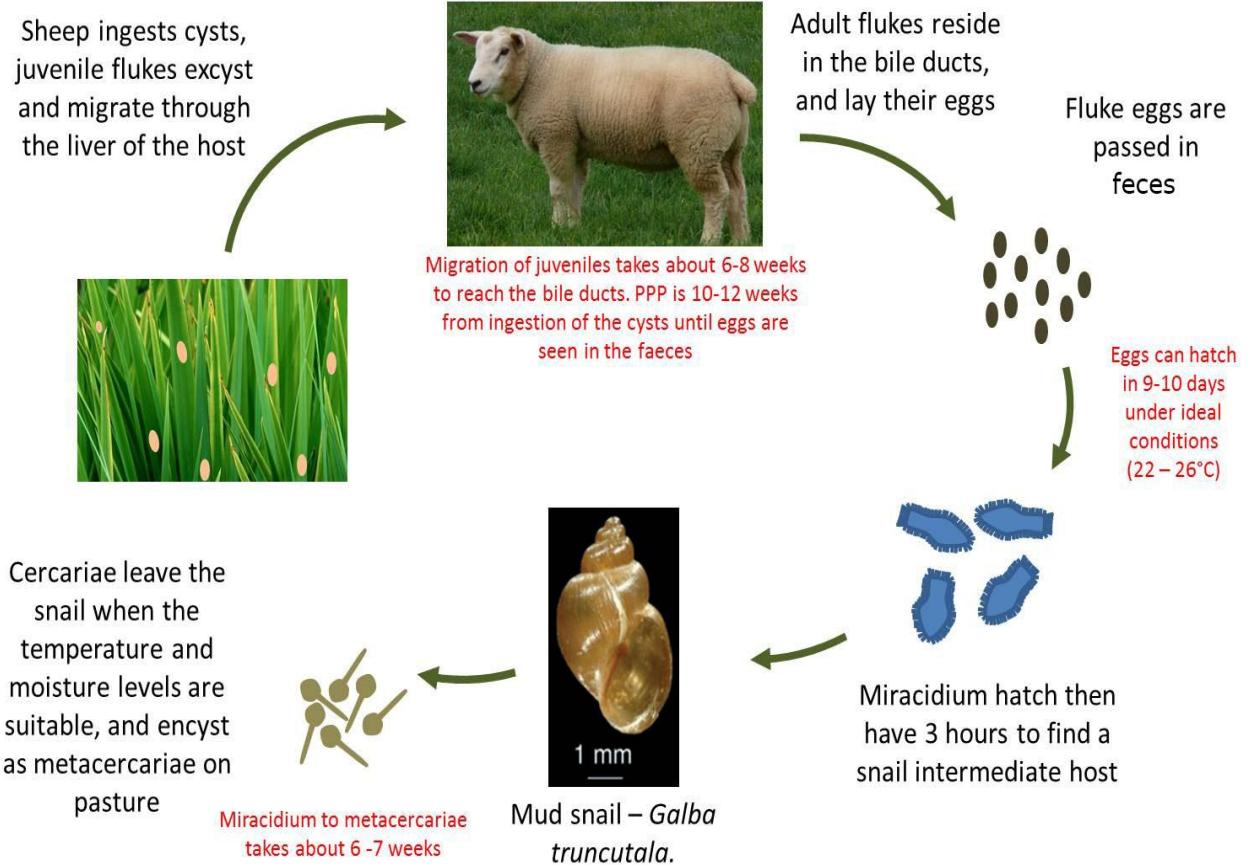
These include

### 4. LIVERFLUKE



- Liverfluke inhibit bile duct of sheep and goats
- They cause damage to the liver.

### LIFE CYCLE OF LIVERFLUKES



### EFFECTS OF LIVERFLUKE ON GOATS AND SHEEP

- f. Digestive upset due to blockage of bile duct.
- g. Swollen abdomen
- h. Demaciation (loss of body weight)
- i. Oedema in jaws (swelling)
- j. Death due to severe demaciation

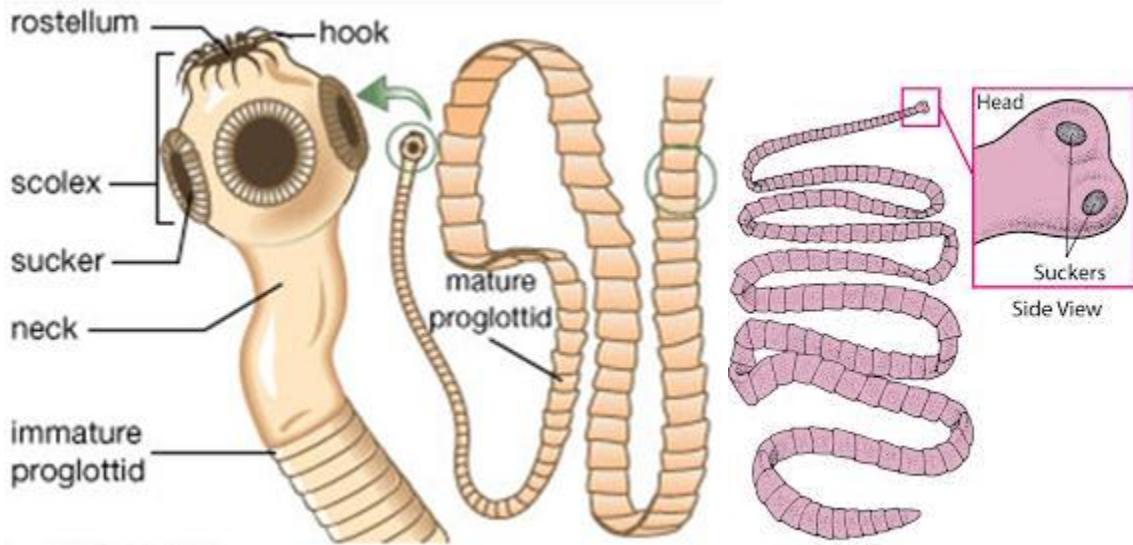
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