PHYSICAL PROPERTIES OF THE SOIL

Physical properties of the soil are the features of soil that you can touch, feel, see and measure.
The physical properties of the soil are soil texture, soil structure, depth, colour, temperature, consistency and porosity (how it leaves small holes or spaces between its particles.

1. SOIL TEXTURE

This refers to how course (rough) or smooth the soil is. It is the relative proportion of various sizes of mineral particles in the soil that is sand, silt and clay
Soil contains particles of various sizes like gravel, sand, silt and clay. These particles determine the texture of the soil.
Table below shows the particles of soil and their estimated sizes.

Soil particle	Diameter (in mm)
Gravel	2.00 and above
Large sand	0.20-2.00
Fine sand	0.02-0.20
Silt	0.002-0.02
Clay	0.002 and below

Soil texture can be determined using :
Feel method
Sedimentation method
Sieving method.

FEEL METHOD

Soil is made wet and squeezed between the forefinger and the pointing finger. Clay soil feels sticky while sand soil feels gritty/course.

SEDIMENTATION METHOD

Sedimentation is the process of separating soil particles to form layers at the bottom of a liquid.
These particles separate and form layers according to their various sizes.
This method helps someone to know which particles are in abundance in a soil sample.

SIEVING

This involves placing the soil sample on a sieving device. Sieves of different mesh sizes are used to separate the soil constituents (sand, silt and clay)
The proportion of sand, silt and clay is later expressed as a percentage. Once the percentages are known, the soil triangle (triangulation) is used to classify the soil. ***(See strides Agriculture book 3 page 3)***

TEXTURAL CLASSES OF THE SOIL

A textural class of soil described based on texture.
Three main textural classes of the soil are sand soil, clay soil and loamy soil.
Sandy soil has more sand particles than any other particles (more than 70% sand particles)
Clay contains over 40% clay particles.
Loam soil contains equal proportions of sand and clay particles.
Other textural classes of the soil are sandy loam, silt loam, clay loam and silt.

CHARACTERISTICS	SANDY	CLAY	LOAM
Particle size	0.02-2.00mm	Below 0.002	Medium
Drainage	High	Low	Medium

Water holding capacity	Low	High	Medium
Aeration	More	Less	Medium
Nutrient-holding capacity	Low	High	Medium
Cultivation	Easy	Difficult	Moderate
Root penetration	Easy	Difficult	Moderate

EFFECTS (IMPORTANCE) OF SOIL TEXTURE ON CROP PRODUCTION .

(a) Water holding capacity

Clay soil with fine particles keeps more water than sandy soils.

(b) Cultivation

Clay soils are difficult to cultivate than sandy soils.

(c) Drainage

Clay soils are usually poorly drained hence waterlogged than sand soils. This is because clay particles are very fine. Crops do not grow well in waterlogged soils.

(d) Aeration

Soil texture determines free circulation of air in the soil. Air moves easier in sand soil than clay soil.

(e) Soil erosion

Sand soils are easily washed away by water or easily washed by water or easily blown away by wind. Clay particles hold together stronger than sand particles and therefore are not easily eroded.

(f) Nutrient holding capacity.

Sand soils easily lose nutrients due to leaching and therefore are less fertile than clay soils.

QUALITIES OF A GOOD TEXTURE (LOAM SOIL)

1. It retains water for plant growth
2. It is well-drained and aerated
3. It is able to supply nutrients to growing plants
4. Plant roots and shoots are able to grow and penetrate with ease.
5. Easy to cultivate at different moisture content.
6. Presence of micro-organisms that decompose organic matter
7. Soil that retains nutrients and resist soil erosion

2. SOIL STRUCTURE

This is the way individual particles are arranged or packed to form aggregates.

The aggregation is through cementing agents like matter and clay.

Soil structure influences:

1. aeration
2. water holding capacity
3. drainage
4. ease of cultivation

TYPES SOIL STRUCTURE.

These are identified through the shape of the soil particles and their arrangement.

1. Flat or plate like – particles are plate shaped and arranged horizontally. They provide poor aeration, hindering water percolation and root penetration
2. Prism/columnar shaped – particles are prism shaped and arranged vertically.
3. Block or many sided – particles are block shaped and vertically arranged in blocks.
4. Round or spheroidal – particles are arranged around a central point and may be granular or crumb in shape.

Question: Using diagrams describe the types of soil structure

EFFECTS OF SOIL STRUCTURE ON CROP PRODUCTION.

(i) It influences the balance between air and water in the soil. Small pores retain water, poor aeration and hence poor seed germination and root respiration.

(ii) It affects soil consistency which impacts on soil 's workability.

WAYS OF MAINTAINING AND IMPROVING SOIL STRUCTURE

(i) Cultivating the soil at the right moisture content or constancy. This ensures that the soil aggregates are not broken down.
(ii) Protecting soils from raindrop impact through planting vegetative cover like grass to prevent splash erosion.
(iii) Using machinery properly to avoid breaking down soil aggregates e.g. avoid use of heavy machinery drawn by tractors which can damage the soil.
(iv) Adding manure and other organic matter, which produce a cementing effect e.g. humus has a binding effect on sandy soil.
(v) Avoid overgrazing which makes the soil vulnerable to soil erosion.
(vi) Crop rotation – fibrous rooted crops helps to bind soil particles together and promote aggregation. Leaving the land fallow helps the soil to rebuild itself.

3. SOIL COLOUR

This refers to the physical appearance of the soil.
Soil colour is influenced by:

(i) Presence and amount of organic matter e.g. dark/black soil colour indicate presence of humus.
(ii) Soil aeration e.g. greyish colour indicates waterlogged and poorly aerated soil.
(iii) Drainage – greyish colour indicates poorly drained soils.
(iv) Type of parent material e.g. a soil which contains a lot of iron oxides is usually red, yellow or brown. A soil containing mica has a glittering appearance. A soil rich in silica (quartz) tends to be whitish or greyish – white in colour.

4. SOIL TEMPERATURE

This refers to the degree of hotness and coldness of the soil.
Soil temperature affects:

(i) Seed germination.
(ii) Transpiration and evaporation.
(iii) Root growth.
(iv) Chemical reactions in the soil.
(v) Activities of soil microorganisms.
(vi) Maturation and the drying of crops.

Soil temperature is affected by:

(i) Soil colour – dark soils tend to absorb more heat energy than light soils.
(ii) Vegetative cover – bare soils warm up easily during the day and cools more rapidly at night.
(iii) Slope of the land – a garden which slopes towards the north is heated more than land which faces south.

WAYS IN WHICH SOIL TEMPERATURE CAN BE MODIFIED OR ALTERED

1. Mulching crops which reduce soil temperature by providing shade to the soil.
2. Planting vegetative cover also provide shade to the soil.
3. Irrigating the soil helps to cool the soil
4. Draining the soil also helps to warm the soil.

5. **SOIL CONSISTENCY.** It refers to the degree of cohesion of the soil particles and the resistance offered in the force to rupture or break up the soil aggregates. It is determined by the structure, texture of the soil, the cementing materials and the pore spaces.

Soil consistency affects the presence of water availability in the soil.
It also affects the workability (ability to be cultivated) of the soil. That is soil can be destroyed if cultivated when it is too dry, and stick to implements when cultivated wet.

Soil consistency can be modified by draining the waterlogged soil.

6. **SOIL POROSITY.** It refers to the air spaces between soil particles. It depends on the texture of the soil. The structure of soil affects porosity as in Sand soil porosity is low because the pore spaces though big are very low. On the contrary, porosity in clay is high because the pore spaces though tiny are many hence retain a lot of water. The pore spaces in sandy soil which are large in size, mostly influence air flow.

Thus porosity is important for crop production because it influences air and water movement in the soil.

7. **SOIL DEPTH**

This is the profile of the soil. A vertical cut through the soil horizons (layers) gives depth.

a. Relief influences the depth of the profile. On hilly areas, there is a shallow profile whereas at the foot of the hills, the profile is deep. In desert regions the profile is shallow while in regions of higher rainfall the depth of the profile increases.
b. The parent material also affects soil depth. As soils from parent material that is resistant to weathering is shallow as opposed to those formed from parent material that weathers more easily.

Soil depth affects root development and the amount of water held by the soil.

WAYS OF MAINTAINING AND IMPROVING PHYSICAL PROPERTIES OF SOIL

Physical properties of soil	How it can be maintained or improved
Soil texture	Very little can be done Should be cultivated at the right content Using appropriate physical conservation measures that reduce soil erosion
Soil structure	Applying organic matter Cultivating at the right moisture content Practising crop rotation Planting vegetative cover Soil conservation
Soil colour	Adding organic manure Draining the soil
Soil temperature	Mulching Planting vegetation cover Draining the soil if it has too much water Irrigating the soil to cool down the temperature
Soil consistency	Draining and cultivating at the right moisture
Soil depth	Using appropriate farming equipment Draining the soil
Porosity	Adding organic material

SOIL PH (POTENTIAL HYDROGEN)

Soil PH is the acidity and alkalinity of the soil or soil reaction. It is also referred to as the concentration of hydrogen ions. The hydroxyl ion (OH-) and the hydrogen ion (H+) determine soil PH. For example, the soil becomes acidic when the soil has more hydrogen ions than hydroxyl ions attached to soil particles. Then soil is alkaline when the hydroxyl ions are greater than hydrogen concentration. But when these ions are of equal concentrations the PH is neutral (PH 7).

WAYS OF INCEASING HYDROGEN ION CONCENTRATION

a. Leaching or washing away of other mineral elements wich are replaced by hydrogen ions.
b. The application of acid –forming fertilisers, like sulphate of ammonia.

A PH of 7 is neutral, PH is low (acidic) when below 7, and PH is high (alkaline) when above PH 7

WAYS OF MEASURING SOIL PH

i. Universal indicator, where the indicator changes to red when acidic, and the indicator will turn blue if the soil is alkaline or basic.
j. Use of PH meter, Litmus paper, where the blue litmus paper will turn red if the soil is red, while the red litmus paper will turn red if the soil is alkaline.

FACTORS AFFECTING SOIL PH

a. Leaching, Some plant mineral elements such as calcium, sodium, magnesium, and potassium are leached down, are replaced by hydrogen ions which increase the soil Rainfall. High rainfall areas are more acidic because the basic nutrients such as calcium and magnesium are leached down and replaced by acidic elements such as aluminium and iron.
a. Pollution of the soils as man activities exhaust fumes from automobiles polute soil with carbon dioxide forms carbonic acid which increases soil
a. Farming activities as monocropping encourages leaching which reduces the mineral content in the soil lowering the PH.
b. The parent material from which the soil was formed like limestone have higher PH values than acid rocks.
c. The heavy and continuous use of acid- forming fertisers like sulphate of ammonia makes the soil acidic.
d. Microbial activity. During decomposition microbial activity increases soil PH as hydrogen ions are released. Also the carbon dioxide in microbes dissolves in water and forms carbonic acid which increases soil PH
e. Weathering of parent material. Soil PH is increased if it contains sulphur. Soils formed from limestone have a high PH.
f. Nutrient uptake by plants tend to be replaced by hydrogen ions which lower the soil ’s acidity.
g. Poor drainage. Soil PH is low in sandy soil than in clay soils due to leaching.
h. Type of vegetation. It protects the soil against rainfall impact and soil erosion. For example soils in forests have lower PH than those in grasslands where loss of nutrients through leaching.

THE IMPORTANCE OF SOIL PH IN CROP PRODUCTION

a. Crop growth as different crops are suited in different soil PH like acidic soils like tea, pine apples, berries, while other crops like beans, groundnuts, cabbages, sunflower prefer alkaline, while maize, wheat rice, cotton water melons and cow peas are moderate between 5 and 6,5.
b. Availability of soil nutrients needed for plant growth as most plant nutrients like phosphorus, Nitrogen, Calcium, Potsssium are available when the soil PH is between 6 and 7.

c. It also affects microbial activities in the soil as bacteria (Nitrification and fixation) and fungi that are important for the decomposition of organic matter tend to be active when the PH is above 5,5 and tolerate a wide range of PH respectively.

WAYS OF MODIFICATION OF SOIL PH

a. Acidic soils can be corrected by adding lime or fertilisers containing calcium ammonium nitrate which neutralize soil acidity.
b. Soil PH can be decreased through the addition of acid forming fertilisers such as sulphur or phosphate fertilisers.

FACTORS AFFECTING THE NUTRIENT STATUS (CHEMICAL PROPERTIES) OF SOIL

a. The composition of the soil as the inorganic (mineral) and organic affect the ability of the soil to retain and release plant nutrients. For example the availability of organic matter affect the ability of soil to retain nutrients.
b. Soil structure and texture as nutrient status of the soil by influencing the physical, chemical and biological properties of soil. For example, big particles of soil that are loosely arranged tend to loose nutrients easily through leaching hence loss of soil fertility.
c. Farming practices affect the availability and the removal of plant nutrients. For example, practices like bush fire and overgrazing destroy organic matter, vegetative cover, as well as loss of nitrogen, and improper use of machinery destroys soil structure.
d. Soil acidity affects the release of nutrients and microbial activities in the soil as low PH does not encourage work of bacteria hence lowering fertility.
e. Crop removal especially when residues are removed without being returned lead to loss of nutrients and when the residues are returned add fertility.
f. Leaching as during heavy rainfall soluble nutrients are washed down the soil profile leading to loss of nutrients.
g. Soil erosion where nutrients are washed away from the top soil by running water unlike when the soil is not exposed to erosion does not loose fertility.
h. Use of basic chemical fertilisers which boost the amount of nutrients in the soil unlike acid forming fertilisers affect the availability of other nutrients in the soil.

CATION EXCHANGE CAPACITY (CEC)

Refers to the ability of the soil to exchange cations (at a given PH and per unit weight of soil).
The nutrients are in the form of positively charged ions called cations and negatively charged charged ions called anions. Examples of cations are Ca++, Mg+, Na+, and K+. Examples of anions are CI-, NO-3 and CO-3. The cations are not easily leached from the soil. However, they can be replaced by, or exchanged with, ions in the solution through the cation exchange process.
An example of a cation exchange process is when lime is added to acidic soil (with a high concentration of hydrogen ions). The calcium and magnesium in the lime will replace the hydrogen ions, thereby raising the soil PH and improving the soil condition.

IMPORTANCE OF CEC TO PLANT GROWTH

a. It affects the availability and release of plant elements vital to plant growth.
b. It affects the ability of roots to uptake the nutrients. For example, high concentration of one cation forces other cations off the colloid and takes their place.
c. It affects the ability of the soil to attract and hold cations. For example, clay has a greater capacity to attract cations unlike sand which has no electric charge. Sand soil can be improved by adding organic matter.

SALINITY

It is a condition of soil that is associated with the accumulation of soluble salts in the soil. Soils that have a high concentration of soluble salts are called saline soils.

REASONS WHY SOILS BECOME SALINE

a. Irrigating virgin land with poor quality irrigation water, since as water evaporates, the salts build up in the soil.
b. The application of fertilizers, which may lead to build up salts in the soil.
c. The release of salts into the soil because the parent material contains a lot of salts.
d. Low rainfall and high evaporation which reduce leaching and capillary action.
e. Poor drainage which builds up salts in the accumulated water.

SODIC SOILS

Saline soils contain soluble salts and sodic soils contain high amounts of sodium.

SALINE- SODIC SOILS

Soils which contain both soluble and sodium salts. The amount of salts in these soils are toxic to plants.

EFFECTS OF SALT ACCUMULATION

a. Salts accumulation lead to an increase in the soil PH thus making some nutrients available in the soil.
b. The accumulation of salts affects seed germination, as salts affect water availability permeability of the soil by water and air. This is because the high osmotic pressure reduces the ability of plant roots to suck in water. Also the excess sodium disperse clay resulting in aggregates being broken down which reduces the permeability of the soil by water and air.
c. Salts are toxic to some crops as some crops are sensitive to a high concentration of salts such as citrus, apples, beans while others may tolerate the salts like cotton, barley, rape.

MANAGING SALINE SOILS

a. Irrigating the soils by floodingto ensure that the salts are washed away.
b. Drainage as water is drained it carries some of the salts with it.
c. The application of gypsum that helps to convert insoluble carbonate salts into sulphates which are readily soluble and easily leached through irrigation.
d. Preventing or reducing evaporation
e. Growing salt tolerant crops that can successfully grow in saline soil.

WAYS IN WHICH FARMERS CAN IMPROVE OR MAINTAIN THE CHEMICAL PROPERTIES OF SOIL .

a. Liming the soil to increase soil acidity.
b. Applying organic matter to improve soil structure.
c. Applying fertilisers correctly.
d. Practicing both physical and biological soil and water conservation measures.
e. Practicing crop rotation
f. Controlling bush fires.
g. Planting close-growing crops or/and grass to check erosion.
h. Mulching crops to reduce raindrop impact and retain soil moisture.
i. Practicing mixed cropping.
j. Irrigating land by flooding to remove excess salts.

PLANT PARTS AND THEIR FUNCTIONS

- Generally a plant has two plants namely the shoot system and the root system.
- The shoot system is the part that grows above the soil and the root system is the part that grows below the soil.

1. THE ROOT SYSTEM

- The root system is classified into tap root system and fibrous root system.
- **Tap root system** has one clearly identifiable main root (primary root). Secondary roots (lateral roots) develop from the primary root and tertiary roots develop from the secondary roots e.g. in crops like beans, tobacco, peas, cotton, tomatoes, cabbages, sunflowers.
- **Fibrous root system** has all roots growing from the base of the stem with no main root e.g. in crops like grasses, maize, millet, sorghum and rice)
- Figure below shows the two types of the root systems.

REASONS FOR THE FARMER TO KNOW THE ROOT SYSTEM OF CROPS

- It helps the farmer to apply fertilizers at correct depth. Crops with tap root system need deep fertilizer placement.
- It helps the farmer to raise seedlings for transplanting. Seedlings with tap root system are transplanted while they are small unlike fibrous rooted crops.
- It helps the farmer to select crops for soil conservation purposes. Plants with tap roots are good for soil conservation purposes.
- It helps the farmer to determine the frequency and amount of water for irrigation. Tap roots need more water for irrigation but less frequently than fibrous roots.

THE INTENAL STRUCTURE OF A ROOT

Refer to Strides in Agriculture Book 3 page 31

The root cap

- This is a layer of cells at the root tip.
- It protects the apical meristem as it grows through the soil.

Apical meristem

- This is a point of growth behind the root cap. It is a bundle of meristematic cells. The cells divide and multiply causing the root to grow.

Epidermis

- The is a layer of cells found on the outermost part of the root. It protects the inner parts of the root. The cells provide enormous surface area.

Root hairs

- These are hair-like structures found in the root tip.
- Root hairs absorb more water and mineral salts from the soil than any other parts of the root. They also stick the soil particles thereby helping to anchor the plant in the soil.

Cortex

- This is a group of cells that makes the most part of the root. The cells include collenchyma, parenchyma and endodermis.
- The cortex stores food materials made in the leaves.

Vascular tissues

- This is a group of cells responsible for transportation of materials in the root. It consists of two types of cells. These are;
- Phloem – This transports food materials from leaves to the rest of the plant where they are used in different processes or stored for future use.
- Xylem – This transports water and mineral salts from the soil to the leaves and other parts of the plant.

FUNCTIONS OF ROOTS

(i) To anchor the plant - Roots support the plant to stay upright and get exposed to the sun for the process of photosynthesis to occur.

(ii) To absorb mineral salts and water – roots reach out to absorb water and dissolved mineral nutrients which the plant needs for growth and reproduction.

(iii) To store food – roots store food made in the leaves through photosynthesis e.g. in crops like beetroot, turnips, carrots and yams the root is the harvestable part of the plant.

2. THE SHOOT SYSTEM

- The shoot system is the part of the plant above the soil surface. It includes leaves, flowers, stems and frits.

THE STEM

A typical stem has nodes, internodes and buds.
Nodes are slightly enlarged or swollen areas along the stem. Buds are formed from the nodes. The space between successive nodes is called the 'internode'.

In legumes the nodes and internodes are not clearly visible. The height of cereal plants depends on the number and length of internodes. A plant with more and longer internodes grows taller than the one with less and short internodes.

INTERNAL STRUCTURE OF THE STEM

Figure below shows the internal structure of the stem.

Epidermis

This is the outer layer of the stem. It protects the inner parts of the stem.

Vascular tissue (vascular bundle)

Xylem transport water and mineral salts to the leaves and other parts of the plant while phloem transports food materials that are produced after photosynthesis to all parts of the plant.

Cortex

Cortex is a group of cells surrounding the vascular tissues for food storage.

Vascular cambium

This is a group of cells which produces growth in the stem by increasing the diameter of the stem. They also separate xylem from phloem vessels.

FUNCTIONS OF THE STEM

(i) Supporting and protecting the upper parts of the plant. The stem holds fruits, leaves and other parts of the plant. It protects fruits and leaves from touching the ground and rot.

(ii) Stems display leaves and flowers. The stem holds and exposes the leaves and the flowers in order for photosynthesis and pollination to take place.

(iii) To store plant food. Some stems keep plant food, for example, sugarcane stems, and other plants.
(iv) To produce plant food. Some young stems contain chlorophyll and are able to carry out photosynthesis.
(v) Transporting materials in the plant. Stem conduct food, water and mineral salts from roots to leaves through xylem and from leaves to lower parts of the plant through phloem.

LEAVES
A leaf is a structure in plants that produces food. Plant leaves develop from buds.
The internal parts of the leaf include stomata, upper and lower epidermis, guard cells, palisade cells, spongy cells and vascular tissues (midrib and veins)

FUNCTIONS OF LEAVES
(i) Producing plant food through photosynthesis.
(ii) Controlling the process of transpiration.
(iii) Allowing exchange of carbon dioxide and oxygen in plants for respiration and photosynthesis.

THE FLOWER
The flower is the reproductive part of the plant.
Figure below shows the parts of the flower.

Sepals
The outer part of the flower that look like green leaves and found at the bottom of the flower.
They enclose and protect the inner parts of the flower when it is still a bud.
Sepals are collectively called **calyx.**

Petals
These are usually brightly coloured structures in the flower.
Petals attract insects and also providing a landing platform for insects which are agents for pollination.

Receptacle
This is a slightly swollen stalk that holds all the parts of the flower.

Stamen
This is a male part of the flower. It is made of the filament and anther. The anther produces pollen, which contains male gametes in a flower. The filament that holds the anther provides a passage of materials from the plant for production of semen.

Pistil
The pistil is the female part of the flower. It has three parts: stigma, style and ovary.
Stigma is a flat tip on which pollen lands during pollination.

Style is a tube that extends from the stigma to the ovary. It transports pollen from the stigma to the ovary.
Ovary is a vessel in which ovules (unfertilized seeds) are formed.

FUNCTIONS OF FLOWERS
The main function of the flower is to carry out pollination and fertilization for the plant. Pollination and fertilization enables the plant to reproduce itself.
Pollination can occur within the same flower (self-pollination) or between two flowers (cross-pollination). Agents of cross-pollination include insects and wind)

A SEED
DIFFERENCES BETWEEN PARTS OF A LEGUME AND A CEREAL SEED

Legume seed	Cereal seed
Has two cotyledons	Has one cotyledon
Cotyledons is the major food storage	Endosperm is the major food storage part
Testa is a seed cove r	Pericarp is the seed cover
Shows epigeal germination	Shows hypogeal germination

FUNCTIONS OF DIFFERENT PARTS OF THE SEED

a. Testa. A tough outer coat that protects the seed from fungi, bacteria and insects infections
b. Hilum: A scar which attach ovule to the ovary wall.
c. Micropyle: A tiny pole in the testa that allows water and air to enter the embryo before germination.
d. Radical: A part that grows and develops into the root system of the plant.
e. Plumule: A leafy part of the embryonic shoot.
f. Cotyledons: Contain food reserves used by the plant during the early stages of germination.
g. Endosperm: Forms the food reserves of a seed before germination.
h. Coleoptile: Outermost covering that protects the shoot tip.

(SEXUAL PROPAGATION) PROPAGATION BY SEED
The use of seeds to produce new plant individuals (sexual propagation)
It involves the union of a female gamete (ovule) with a male (pollen grain) during fertilization.

VEGETATIVE PLANTING MATERIAL
Vegetative planting materials are parts of plants other than seeds which can be used to produce new individual plants. The use of vegetative materials for plant propagation is called asexual reproduction.
Examples of vegetative plant parts are:
Stem cuttings (sugarcane and cassava), Leaves, Suckers, Tubers, Bulbs, Splits, Crowns and slips, Food storage organs, Vines.

ESSENTIAL PLANT NUTRIENTS
A plant nutrient is mineral element needed by plant to grow and complete its life cycle. The following are the conditions for a plant nutrient to be essential:

(i) The nutrients must be directly involved in the metabolic processes in plants.
(ii) Its deficiency must cause specific deficiency symptoms in plants.
(iii) The deficiency symptoms can be corrected only by supplying the plant with that nutrient

Plant nutrients can be classified into macronutrients and micronutrients. Plants require macronutrients in large quantities. Macronutrients include: nitrogen, phosphorus, potassium, calcium, magnesium and sulphur.
Micronutrients are required by plants small quantities e.g. iron, manganese, copper, zinc, boron, molybdenum and chlorine.

Nutrient	Function	Sources	Reasons for depletion	Deficiency signs
NITROGEN • Is absorbed by plants as nitrate ions (NO_3^-) or ammonium ions (NH_4^+)	• It gives the dark green colour to plants to leaves because it is part of the chlorophyll molecule. • It is important in formation of protein molecules. • It encourages vegetative growth in plants making the plant to increase in height or length and sizes of leaves. • Makes plants and their fruits succulent. This is an important quality for herbs, cabbages, lettuce, carrots, melons and cucumbers. • It increases yield of cereals and legumes by increasing the size of grain. • It controls the use of phosphorus and potassium in plants.	• Inorganic fertilizers such as Calcium Ammonium Nitrate (CAN-21%N) and Urea (46%N) • Organic manures such as compost and farmyard manure (FYM) • Fixation by symbiotic Rhizobium bacteria and free living bacteria (Azotobacter) through the nitrification process. • Nitrification of atmospheric nitrogen through lightning.	• Volatilisation-nitrogen is released into the atmosphere as a gas through activities of the denitrifying bacteria. • Immobilization-used by micro-organisms to build up their bodies. • Absorption by plants and the consequent removal of crop plants (products) from the land through harvesting. • Soil erosion carries away nitrates, together with the top soil, down the slope. • Leaching. The nutrients (nitrates) are washed vertically down the soil profile to	• Chlorosis (loss of colour) of leaves from the tips of lower leaves in the stem. • Crops ripen prematurely and fruits fall off. • Stunted growth of plants. • Leaves falling down before the plant matures.
PHOSPHOROUS • Is absorbed by plants as $H_2PO_4^-$ especially at lower pH values and HPO_4^{3-} at higher pH values.	• It encourages formation of strong roots and stems. • It encourages seed germination, flowering, fruit formation and maturity of crops. • It speeds up ripening of fruits. • It improves the quality of	• Artificial fertilizers such as single superphosphate, double superphosphate and triple superphosphate. • Organic manure such as farmyard manure compost and green manure.	• Plant absorption and crop removal. • Fixation through adsorption into silicate clays. • Leaching • Soil erosion.	• Reduced root development, especially secondary roots. • Leaves have a purplish colour. • Low and stunted growth. • Poor branching, since lateral buds remain dormant. • Dead spots on leaves and fruits. • Fewer and smaller tubers. • Delayed maturity.

	pastures and vegetables. • It increases the resistance of crops to diseases. • It encourages plant growth because it helps in the production of new cells. • It is important in the process of respiration and manufacturing of fats and carbohydrates. • It is used in enzyme and protein formation.	• Weathering of phosphate containing rocks (apatites) which release phosphate salts like calcium phosphates.		
POTASSIUM • Is absorbed by plants in the form of potassium ions (K^+)	• Makes the stem strong reducing lodging and increasing the plant's resistance to bacterial disease. • It is important in the formation of carbohydrates. • Makes the transportation of fluids in plants possible leading into well-filled seeds and tubers. • Helps in absorption of nitrates from the soil. • Controls the opening and closing of the stomata. • Improves the quality of fruits and vegetables.	• Inorganic fertilizers such as Muriate of Potash (KCl), Potassium Sulphate and Potassium Nitrate. • Organic manures and crop residues. • Potash rocks like mica and feldspar.	• Absorption by plants • Soil erosion. • Leaching • Adsorption (fixation in soil particle of some clays.	• Scorched (burnt) leaf margins from the tips spreading backwards, beginning with lower leaves. • Weak stalks resulting in high plant lodging. • Small fruits, seeds and tubers (shriveled seeds) • Small dots appearing on leaves
CALCIUM • Is absorbed in form of calcium ions (Ca^{2+}).	• It helps the cell walls to be strong. • It helps in transportation and storage of carbohydrates and proteins into seeds and tubers.	• Commercial fertilizers such as CAN. • Crop residues and manure. • Weathering of soil minerals such as limestone. • Agricultural lime such as	• Absorption by plants • Erosion • Leaching	• Terminal buds stop growing. • The young leaves of maize fail to open up. • The plant shed off flowers and buds. • The stems are weak and this results in lodging of plants.

	• It neutralizes soil pH which makes phosphorous and potassium to be available. • It also increases the activities of nitrogen fixing.	dolamite , calcium carbonate and quicklime(CaO)		
MAGNESIUM • Is absorbed as Mg^{2+} ions.	• It is a component of the chlorophyll responsible for photosynthesis. • Increases the amount of oil stores in groundnuts and Soya beans. • Activates enzymes in the metabolism of carbohydrates and nitrogen.	• Inorganic fertilizers • Organic manures • Dolamitic lime • Weathering of magnesium containing rocks	• Plant absorption • Soil erosion • Leaching	• Interveinal chlorosis on leaves where veins remain green while the rest of the leaf is yellow. • Stunted growth. • Lower leaves of cotton turn reddish brown.
SULPHUR • Is absorbed by plant roots as sulphate (SO_4^{2-}) ions.	• It increases the amount of stored oil in sunflower, groundnuts and Soya beans. • It is a constituent of three amino acids: cystine, cystein and thiamine. • Useful in nodule formation on nodule roots for nitrogen fixation. • It is needed in protein synthesis and improves the biological value of proteins	• In organic fertilizers such as ammonium sulphate and 23:21:0+4S. • Oxidation of sulphides such as copper sulphide ($CuSO_2$), Iron sulphide ($FeSO_2$) forms sulphates. • Rain water. • Atmospheric sulphur from industries where coal is burnt to release sulpher dioxide (SO_2).	• Plant absorption and crop removal • Valatisation in form of hydrogen sulphide gas (H_2S)	• Leaves turn light green /yellow starting with young leaves. • Small and short plants with thin (spindly) stems. • Reduced nodulation in legumes.
IRON • Is absorbed by plant root as ferrous ions (Fe^{2+}) or ferric ions (Fe^{3+})	• Necessary for the formation of chlorophyll. • Activates various respiratory enzymes.	• Inorganic enriched fertilizers and chelates. • Organic manure.	• Soil erosion • Leaching • Fixation into insoluble forms	• Interveinal chlorosis of young leaves. • Young leaves can turn completely white in severe cases. • Twigs stop growing and die.
MANGANESE • Is absorbed by plants in the form of Mn^{2+} ions.	• Activates enzymes and acts as a catalyst in the formation of chlorophyll.	• Fertilizers like manganese sulphate are used to correct deficiency. • Organic matter.	• Soil erosion • Leaching in acidic soil conditions. • Fixation in alkaline soils.	• Mottled interveinal chlorosis of young leaves. • Interveinal white/brown specks in some cereals.
BORON	• Essential for cell division in	• Inorganic enriched NPK	• Soil erosion • Leaching	• Poor growth and sometimes

• Is mostly absorbed as borate (BO_3^-) ions.	meristematic tissue. • Regulates carbohydrate mechanism. • Important in the transfer of sugars (starch) within the plant.	fertilizers and borax.		terminal buds die. • Shortening of internodes. • Poor grain filling on maize cobs. • Soft or necrotic sports on fruits or tubers.
MOLYBEDUNUM • Is absorbed as molybdate (MoO_4^{2-}) ions.	• Promotes symbiotic nitrogen fixation in legumes. • Increases nitrogen utilization.	• Inorganic enriched NPK fertilizers. • Organic matter.	• Soil erosion. • Leaching in alkaline soils. • Fixation into insoluble forms by ferrous oxides in acidic forms.	• Curling of leaves • Scorching of leaves.

COPPER, ZINC AND CHLORINE

The table below shows the roles and deficiency signs for these trace elements.

Trace element	Available form	roles	Deficiency signs
Copper	Cu^{2+} (cupric ions)	Activates enzymes. Is involved in chlorophyll formation.	Die back of terminal shoots. Wilting and death of leaf tips.
Zinc	Zn^{2+} ions	Chlorophyll formation Stem elongation and root development.	Short stems Formation of white buds Failure of roots to elongate(in woody plants) Uneven striping of leaves Chlorotic young leaves.
Chlorine	Cl^- ions	Produces a suitable burning quality in flue cured tobacco Is needed in photosynthetic reactions.	Reduced root growth in tomatoes, tobacco, potatoes, cotton, maize, etc. Wilting of plants (leaf blade tips) during the early stages of growth. Bronze discoloration of leaves.

WEEDS AND WEEDING

- A weed is an unwanted plant.

CLASSIFICATION OF WEEDS

- Weeds can be classified according to leaf shape, life span, feeding habits, preferred habitat and seed type.
- Proper classification of weeds help farmers identify weeds quickly and find appropriate measures to control them.

1. Leaf shape.

- Narrow-leaved weeds: they have narrow leaves with parallel veins e.g. Guinea grass and couch grass.
- Broad-leaved weeds: they have broad leaves with net veins e.g. black jack and pig weed.

2. Life span

- Annuals: These weeds complete their lifecycle in one growing season.
- Biennials: These weeds require two growing season to complete their life cycle. They grow vegetatively in the first season and produce seeds in the second season and die e.g. wild carrots and blue thistle.
- Perennials: These live longer than two years. They produce new plants year after year e.g. tubers, corms, crowns, rhizomes and stolons.

3. Feeding habits

- Parasitic weeds: These depend on food from the crop that is in the field e.g. witch weed in Maize, dodder in plantation tree crops and herbaceous plants (vegetables) and mistletoe in orange, tangerine, coffee and rubber.
- Non parasitic weeds which manufacture their own food.

4. Preferred habitat

- Aquatic: Weeds adapted to leave in water or waterlogged soils e.g. water hyacinth.
- Non aquatic weeds/terrestrial weeds: Weeds which grow on land and not in water.

5. Seed type

- Weeds can be classified into monocotyledonous and dicotyledonous.

THE IMPACT OF WEEDS ON CROP PRODUCTION

a. Decreasing the quantity of crop yields. Weeds compete against crops for mineral nutrients and this makes crops suffer.
b. Reducing the quality of crops. This can be done through contamination or adulteration e.g. during the harvesting of cotton, the lint may be mixed with debris there by lowering its grade.
c. Harboring pests and diseases of crop plants. The weeds provide suitable environment and food for the pests and pathogens (disease causing organisms) to thrive and multiply.
d. Smothering crop plants. Weeds suppress the growth of crops because they become established faster and more aggressively than crop plants. They therefore make it difficult for the crop to carry out photosynthesis as it is shaded from sunlight.
e. Increasing production costs. Fields with higher weed population will need more labour to harvest and controlling the weeds might also be expensive.
f. Reducing the value of agricultural land. Weeds are generally heavy feeders as such, they lower the nutrient status of the soil.
g. Poisoning livestock. Some weeds e.g. fireball, lantana cause illness or death to farm animals.
h. Some of aquatic like water hyacinth can block irrigation channels or increase the rate of evaporation of water.
i. The aquatic may also block the fish and other aquatic animals of oxygen causing them to die.
a. Increasing the cost of production through increased labour costs, purchase of herbicides, impediment of harvesting of the crop.

BENEFITS OF WEEDS

a. Vegetables. Some weeds are used as vegetables such as pigweed and black night shade.
b. Medicinal value. Some weeds are traditionally used as herbal medicine to cure diseases in humans and farm animals like roots of Sodom apple are used to treat constipation.
c. Soil vegetative cover. Weeds minimize loss of moisture through reduction of evaporation rate because of the covering of the soil.
d. Source of soil nutrients. When weeds decompose they release nutrients into the soil which are made available for use by crops. Leguminous weeds also fix nitrogen in the soil.
e. Mulching material. Dead dry weeds may be used as organic mulch for crops.
f. Livestock feed. Some weeds serve as feed for livestock and wild game like black jack.

FACTORS CONTRIBUTING TO THE COMPETITIVE ABILITY OF WEEDS

a. Weeds produce a very large number of viable seeds like black jack.
b. Ability to withstand unfavorable conditions as they are able to remain viable in the soil for a long time until suitable germination conditions set in.

c. Some weeds have good dispersal mechanisms that make them spread fast like gallant soldier, black jack, devil 's horse whip.
d. Some weeds propagate by use of vegetative parts for example wandering jew, nut grass, couch grass.
e. Most weeds are able to grow fast and reach maturity early and produce seeds within a short period of 3 months.
f. Weeds have the ability to survive even in soils with low nutrient level such as couch grass and double thorn.

METHODS OF CONTROLLING WEEDS

PHYSICAL CONTROL

- This involves uprooting weeds by hands. This method can be successful if:
  (i) Weeds are uprooted before flowering to prevent seed multiplication.
  (ii) Weeds are uprooted before their roots intervene with those of crop plants.
  (iii) The uprooted weeds are effectively disposed so that there is no chance for regeneration.
  (iv) The soil is moist enough to enable the uprooting of the entire weed.
  (v) The weather is sunny so that the uprooted will weeds will quickly dry out and die.

(i) Table below shows advantages and disadvantages of physical weed control.

Advantages	Disadvantages
➢ Efficient for removing weeds on planting stations without any injury to plants	➢ Very slow and not suitable for large farms
➢ Requires little or no investment in farm tools	➢ It is very tiresome
➢ Requires no specific skills	➢ May not be effective if the weeds break up leaving the roots to produce new shoots.
➢ Is cheap where labour is in large numbers.	➢ May result in transplanting the uprooted weeds if they are not effectively disposed off.
➢ Sure way of killing weeds if the entire root system is removed.	➢ The weeds have enough time to use the food crop as hand weeding waits until the weed is at stage where it can be pulled out.

CULTURAL CONTROL

- Cultural weed control involves the use of crop husbandry practices to control weeds. Such practices encourage the crop to grow well and faster than the weeds. Such crop husbandry practices include the following:
  (i) Burning the land during land preparation-destroys weed seeds.
  (ii) Deep tillage so that weed seeds are buried deep thereby taking long time to germinate.
  (iii) Flooding e.g. in rice fields suffocate and kills non-aquatic weeds.
  (iv) Crop rotation so that the lifecycle of the weeds is broken.
  (v) Early planting so that crops grow faster and mature earlier before weeds grow.
  (vi) Correct spacing to ensure adequate ground cover so that weed growth is suppressed.
  (vii) Correct fertilizer placement so that crops grow faster to suppress weed growth.
  (viii) Mulching-covering the soil with materials denies weeds light.

Advantages

(i) Easy to use
(ii) Cheap
(iii) Does not require extra effort as normal husbandry practices are used.

Disadvantage

- It does not control all the weeds.

MECHANICAL WEED CONTROL

- This is the use of farm tools and farm implements to control the weeds e.g. hoes , ploughs, cultivators, sickles, mowers and slashers.
- Processes of mechanical weed control include:

(i) Slashing to cut down weeds. This only slows the growth of weed so that the established crop can compete more successfully by smothering the weeds. This process is used in well established woodlots and orchards.

(ii) Hoeing out weeds. This is scrapping or rifting weeds out of the soil using a hoe. This exposes the weeds to the sun 's heat which kills them.

(iii) Trimming down the weeds o reduce the height of weeds such as star grass. Lawn mowers can be used to trim down weeds.

(iv) Digging out weeds. An ox-drawn or tractor drawn implements can be used to dig out or burry weeds into the soil.

Advantages	Disadvantages
➢ Faster so large plots can be weeded in time. ➢ Less tiring than physical weeding.	➢ Expensive since it uses equipment. ➢ May not completely eliminate weeds. ➢ May require skill to some of the equipment. ➢ May result in some crops being cut down. ➢ Cannot control weeds within the rows of crops.

BIOLOGICAL CONTROL

- This is the use of natural enemies of weeds e.g. animals, insect pests and plant pathogens to keep the weed population on check.
- Insects like ants can also kill and eat the weeds.

Advantages	Disadvantages
➢ Make use of natural enemies ➢ Does not require any labour other than just introducing the pests into the filed.	➢ Requires careful attention to maintain balance between the pest and the weed. ➢ It is difficult to breed host-specific pests for weed control. ➢ Cannot be used to eradicate (get rid) of weeds.

CHEMICAL WEED CONTROL

- This involves use of substances or compounds which destroy the weed but not affect the crop. Such substances are called herbicides.

Classification of herbicides

1. In terms of use:-

(a) Selective herbicides-destroy a particular group of plants without harming other plants e.g. Dalapon kills monocots (grasses) while 2,4D acid and 2,4,5-T kill broad leaved weeds.

(b) Non selective herbicides-kill any plant e.g. Paraquat.

2. In terms of mode of action.

(a) Contact herbicides-kill the weeds when they are in direct contact with them e.g. Bentazone and Prapanil.

(b) Translocated (systemic) herbicides-get translocated to other plants through the vascular system (xylem and phloem) to kill the weeds e.g. Atrazine, Simazine and Diuron.

(c) Soil sterilants-prevents germination and growth of weeds e.g. Bromacil.

3. Time of application

(a) Pre-planting herbicides e.g. soil sterilants like methyl bromide.

(b) Pre-emergence herbicides-before the emergence of the weed or crop e.g. lasso.

(c) Post emergence herbicides-after emergency of the crop or weed e.g. 2, 4-D.

Advantages of chemical weed control

(i) Reduces early weed competition –pre-emergence herbicides.
(ii) Reduces labour demand for weeding.
(iii) Ensures timely control of weeds and cultivation of large hectarage.
(iv) It is quick in controlling weeds.

Disadvantages

(i) It can destroy crops if not properly diluted.
(ii) It is expensive to purchase herbicides and equipment for application.
(iii) Some herbicides can harm people or livestock.
(iv) It is less effective if the application is followed by rainfall.
(v) It needs skill especially on handling and application of chemicals.

LEGISLATIVE CONTROL

- This method uses laws to control weeds and their spread.
- This method prevents new weeds from getting into the country or existing weeds from spreading to other areas. Legislative weed control aims at preventing noxious weeds from invading the country. In this method the authorities:
  (i) Inspect products coming into the country at entry points like sea ports, airports, borders and other entry points. They impound and destroy all dangerous weeds to prevent them from spreading in the country.
  (ii) Ask people to report when they suspect products which can bring dangerous weed seeds.
  (iii) Quarantine imported crop products. This helps to observe them for a reasonable time to make sure they are weed free.

Advantages	Disadvantages
➢ It prevents strange weeds from entering the country. ➢ It is free to the farmer	➢ Smuggling of products makes the system less effective. ➢ It is difficult to enforce. ➢ Does not control weeds in individual farms. ➢ It covers only selected weeds.

PROTECTING CROPS AGAINST PESTS AND DISEASES

- Crop protection means keeping cultivated plants safe from organisms that could cause damage and reduction in crop yields and the farmer 's income.
- A pest is an organism that causes harm to the crops or animals.
- A disease is a physiological or anatomical disorder or abnormality in a plant which can be identified through characteristic symbols in a plant.
- Diseases are caused by pathogens (bacteria, viruses, fungi, nematodes) and physiological factors i.e. physical, chemical and climatic factors that cause disorder in plants e.g. low soil pH, low nitrogen content in the soil and drought.

GROUPS OF PESTS

1. Mammals e.g. monkeys, warthogs, rats, mice and namfuko (giant rat)
2. Birds e.g. Guinea fowl, weavers, doves and redheaded queleas.
3. Nematodes (eelworms) -tiny worms that are round in shape. They damage inner parts of the plant; suck sap and cause root swellings. Are common pests of tobacco, Irish potatoes and tomatoes?

4. Insects e.g. aphids, grasshoppers and locusts.

BITING AND CHEWING INSECT PESTS

- These are insect pests which bite and chew parts of the plant e.g. grass hoppers. The mouthpart has mandible for cutting and chewing.

- **PIERCING AND SUCKING PESTS**
- Their mouthparts have sharp needle like stylet (proboscis) shaped e.g. aphids, fruit flies, cotton stainers and mealy bugs.

BORING INSECT PESTS

- These have mouthparts adapted for biting and chewing. They tunnel (drill holes) e.g. stalk-borer and weevils.

HARMFUL EFFECTS OF PESTS

(i) Transmit diseases because they are vectors (disease carriers). They inject toxic saliva that kill or poison plant tissues and pierce plant parts.
(ii) Lowering the quality of yield by puncturing fruits or seeds, blemish and contaminate the produce.
(iii) Reducing the quantity of yield by eating roots, boring stems, eat plant leaves, consuming fruits or seeds, sucking sap, feeding on flowers and destroying apical buds.
(iv) Increasing the cost of production by causing the farmer to buy and use pesticides demanding time for inspection and controlling them.

HARMFUL EFFECTS OF DISEASES ON CROPS

(i) Damages roots causing root lodging.
(ii) Injuring roots through root knots. This reduces the absorption of water and mineral salts from the soil e.g. root knot.
(iii) Attack the stem and this disturbs the flow of nutrients and water in the plant.
(iv) Attack leaves reducing photosynthesis activities. This results into stunted growth and low yield e.g. leaf spot, bacterial blight and rosette.
(v) Attack fruits and seeds which reduce the market value of the commodity e.g. blight of tomatoes.

EXAMPLES OF COMMON PESTS IN MALAWI AND THE DAMAGE THEY CAUSE

Pest	Mouthpart	Damage to crops	Affected crops
Army worm	Biting and chewing	An army of larvae invades and eats up entire young succulent crops.	Grasses (cereals)
Termites	Biting/chewing	Workers eats up growing mangoes	Cereals, citrus
Bud worms	Biting/chewing	Caterpillars eat up buds of plants	Tobacco, tomatoes.
Locusts	Biting/chewing	Adults and nymphs eat up leaves	Cereals, cassava, vegetables
Cutworms	Biting/chewing	Caterpillar eats stem of young plants at ground level	Vegetables, seedlings of maize.
Aphids	Piercing/sucking	Nymphs and adults suck sap from plant cells and transmit diseases	Groundnuts/beans

Cotton stainer	Piercing/sucking	Adult suck juices, distorts leaves and transmit diseases.	Cotton
Maize weevil	boring	Adults bore into grain to lay eggs	Maize
Stalk borer	boring	Caterpillar tunnels into stems	Maize, sorghum, sugarcane
Warthogs	Biting/chewing	Dig up and eat cassava tubers	Cassava
Monkeys	Biting and chewing	Eat the grain between milky stage and grain development	Maize

EXAMPLES OF COMMON DISEASES IN MALAWI

Disease /cause	Symptoms	Control	Crop affected
Maize streak/virus	Chlorotic areas appear parallel to the veins	➢ Rogueing infected plants ➢ Planting early ➢ Spray Actelic 85wp to kill vectors (leaf hopper)	Maize
Maize rust / fungus	Tiny brownish or reddish spots with raised appearance on leaves.	➢ Early planting ➢ Growing resistant varieties ➢ Using certified seeds ➢ Treating with fungicides.	Maize
Northern leaf blight /fungus	Papery large brown spots on leaves. Dead spots on leaves	➢ Growing resistant varieties ➢ Early planting	Maize
Headsmut /fungus	The cobs and the tassels are covered by black substances (spores)	➢ Planting clean seeds ➢ Planting resistant varieties ➢ Treating seed with suitable fungicides.	Maize
Rosette /virus transmitted by aphids	Curled, tiny leaves Variegated leaves (green/yellow patches) Stunted plants (or dwarfism)	➢ Planting resistant varieties e.g. RG1 ➢ Uprooting and burning infected plants ➢ Close spacing ➢ Early planting	Groundnuts
Bacteria blight/bacteria	Angular dark brown spots on leaves. Bolls rot	➢ Closed season ➢ Uproot and burn stalks after harvesting. ➢ Growing resistant varieties. ➢ Planting treated seed	Cotton, cassava
Cassava brown streak virus disease (CBSVD)	Yellow mottling with green leaf ground on the bottom of leaves.	➢ Rogueing infected plants ➢ Planting disease-free materials.	Cotton
Cassava Mosaic /virus	Mottled and curled leaves Stunted growth. Veins look clear.	➢ Planting disease-free materials ➢ Uprooting and burning infected plants.	Cassava
Rice blast/fungus	Oval brown spots on leaves and stems Stems break	➢ Correct plant spacing. ➢ Burning infected crop residues ➢ Proper water control.	Rice

Leaf spot of rice/fungus	Dead spots on leaves	➢ Planting certified treated seeds using suitable fungicides.	Rice
Anthracnose /virus	Brown spots on leaves, stems, pods or fruits.	➢ Spraying Dithane ➢ Spraying Daconil	Beans
Angular leaf spot/fungus	Dead brown spots which may join up to form large spot between midrib and net vein.	➢ Spray Daconil	Beans

METHODS OF CONTROLLING PESTS AND DISEASES

A. PHYSICAL CONTROL

- This refers to use of direct human efforts or mechanical devices to remove or destroy the pests and disease.
- These include: hand picking, fencing, frightening off pests, painting stick bands, erecting concrete foundations, flooding fields, using rat guards, trapping, using airtight storage facilities and chilling and heating.

B. CULTURAL CONTROL

- Refers to the use of normal husbandry practices (agronomic practices) that prevent or reduce the multiplication or spread of pests and diseases.
- These include:
  - (i) Tilling the soil-either exposes some soil pests or soil borne diseases to the sun or bury some pests.
  - (ii) Rotating crops – changing crops on a plot controls host specific pests and diseases.
  - (iii) Planting early – crops are well established before pests and diseases build up and mature early escaping late pests and diseases.
  - (iv) Planting clean healthy seeds – seed borne diseases like head smut in maize and white flies are controlled.
  - (v) Removing volunteer plants – these are plants that grow by themselves from seeds left in the soil from the previous crop. These make crop rotation disturbed.
  - (vi) Weeding early – remove early since they invite and keep pests and diseases.
  - (vii) Maintaining a recommended plant population – controls the rate of transmitting pests and disease causing organisms from one plant to another e.g. close spacing of groundnuts controls the spreading of aphids which transmit rosette.
  - (viii) Applying organic matter and inorganic fertilizers –make plants to grow strong and vigorous. Such plants are able to resist disease and pest attack.
  - (ix) Removal of crop residues – prevents the transmission of pests from one season to another.
  - (x) Intercropping or mixed cropping – one crop acts as a barrier against pests (catch crop) or as an alternate host to divert pest away from the susceptible crop.

C. LEGISLATIVE PEST AND DISEASE CONTROL

- This is the use of laws and regulations which prevent a country from importing pests and diseases. These include:
  1. Prohibition-laws or regulations forbidding the introduction of specific agricultural materials that may be a source of infection in an area.
  2. Quarantine – a period of isolation and observation of products in sealed compartments, long enough for any diseases symptoms to appear.
  3. Notification order – the order that require that the occurrence of notorious pests and diseases be reported immediately to appropriate authorities or the police e.g. army worms and red locusts.

4. Closed season – a period when a particular crop is not allowed to be growing in the field e.g. tobacco, cotton to starve out pests.
5. Seed Certification – seeds are inspected and certified free of pests and diseases before they are sold to farmers.

D. BIOLOGICAL CONTROL

- Use of living organisms such as predators, parasites and pathogens to reduce the population of pests.
- **Predators** are animals that prey on other animals e.g. chicken prey on cotton stainers, crows, army worms while lady birds prey on aphids.
- **Parasites** are organisms that depend on another organism for food and shelter e.g. diptera on grasshoppers.
- **Pathogens** are disease causing organism like bacteria, fungi and viruses which can attack pests making them sick and later dies e.g. viruses control armyworms and bacillum papillae control the larvae of some beetles.
- Biological method of controlling pests and diseases is good because:
  (i) It is cheap because you don 't have to buy the parasites, predators or pathogens.
  (ii) Effective for several years.
  (iii) It does not pollute the environment.

The disadvantages of biological method of pests and disease control are:

(i) It needs knowledge on the behaviour of the pests to be controlled.
(ii) The controlling agent must be safe. The predator itself must not become a pest.

E. CHEMICAL CONTROL

- This involves use of toxic substances that are lethal to crop pests, parasites or pathogens.

METHODS OF APPLYING PESTICIDES

(i) Dusting – used to apply powdered chemicals e.g. malathion, dithane and aldrin.
(ii) Fumigation – used to apply chemicals which are in gaseous form e.g. methyl bromide to control nematodes.
(iii) Spraying – used to apply chemicals which can dissolve or mix in water through spraying.

MODE OF ACTION

- Pesticides kill the pests in the following ways:
  1. By contact – the chemical kills when the pest touches it.
  2. By eating (stomach poisons) – pests die when they eat parts of the crop which have pesticides.
  3. By inhaling (respiratory poisons) – pests die when they breathe in the molecules of the pesticides. This causes suffocation and death of the pest.
  4. By systemic means (systemic poisons) – the pesticide is absorbed by plant roots and transported to all parts of the plant through the xylem system and get mixed with sap. The pests get the chemical when they eat or suck sap and they die.

ADVANTAGES AND DISADVANTAGES OF CHEMICAL CONTROL OF PESTS AND DISEASES

Advantages	Disadvantages
➢ It kills pests faster than cultural or physical control method. ➢ It is easier to apply chemicals than physical control. ➢ Any farmer can use the pesticides.	➢ It is expensive to buy the pesticide. ➢ It can kill beneficial predators and insect pollinators. ➢ It can pollute the environment. ➢ It can result in pest developing resistant to the chemical and becoming difficult to kill.

➢ It is easy to follow the instructions labeled on the package.	➢ Chemicals can also be harmful to people. ➢ Skilled labour is required for mixing and application. ➢ Some pesticides have long residual effects and may in the long term affect future generations of plants and animals e.g. DDT.

GUIDELINES WHEN CONTROLLING PESTS

(i) Comply with laws that minimize the multiplication and spread of pests.
(ii) Use cultural methods always.
(iii) Encourage natural enemies of pests.
(iv) Apply physical control measures whenever time and human resources allow.
(v) Use chemical method as the result resort.

CROPPING SYSTEMS

➢ A cropping system is a practice followed on cultivation and production of plants.

1. SHIFTING CULTIVATION

➢ A cropping system in which land is cultivated for several years until crop yields become too low due to soil exhaustion. Land is cleared by cutting down trees and burning follows.

Advantages	Disadvantages
➢ Cheap – does not require fertilizer. ➢ Simple – uses hand tools. ➢ Control pests and diseases through burning.	➢ Requires a lot of land. ➢ Low yields (no fertilizers) ➢ Burning destroys organic matter and some nutrients.

2. BUSH FALLOWING (LAND ROTATION)

Farming a plot, temporarily leaving it when exhausted and returning to it later when it regains fertility.

Advantages	Disadvantages
➢ Cheap as it does not need a capital for fertilizer. ➢ Regains fertility through fallow periods.	➢ Causes soil erosion due to deforestation. ➢ Requires a lot of land.

3. MONOCULTURE

The whole farm has only one crop grown every year.

Advantages	Disadvantages
➢ Highest possible profits since the most suitable crop is grown. ➢ Simplifies farm management – easy to plan and budget. ➢ Facilitates farm mechanizations and the farmer specializes. ➢ Saves costs– large-scale estate farming hence inputs are bought cheaply in bulk.	➢ Pests and diseases build up ➢ Soil becomes exhausted quickly.

4. MONOCULTURE

Cultivating one crop on a piece of land.

Advantages	Disadvantages
➢ Easy to machanise ➢ No competition and easy to use chemicals.	➢ Pests and diseases spread fast in pure stand.

5. MIXED CROPPING /INTER-CROPPING/INTER-PLANTING /MULTICULTURE /POLYCULTURE

- Growing two or more crops on the same piece of land at the same time. It can be intra-row cropping, inter-row cropping and relay intercropping.
- **Intra –row mixed cropping** – two or more crops grown within the same ridge.
- Inter-row mixed cropping – one crop is grown between the rows of another crop.
- Rely intercropping – a second crop is sown while the first one is still growing, established or even maturing (phased planting).

Advantages	Disadvantages
➢ Saves labour – operations are done once. ➢ Saves land ➢ Increased total yield ➢ Reduces pests and diseases and crop failure. ➢ Reduce soil erosion	➢ Difficult to mechanise. ➢ Difficult to use chemicals (fertilizers, pesticides) ➢ Need large capital starting capital ➢ Crops shade one another (competition) ➢ Requires knowledge and skills

6. CONTINUOUS CROPPING

- The growing of crops on a piece of land every year without resting the land.

Advantages	Disadvantages
➢ 100% utilisation of land resource ➢ Reduces soil erosion due to continuous soil cover. ➢ Food security and sufficient cash.	➢ Exhausts soil fertility. ➢ Soil structure is destroyed due to over cropping. ➢ Multiplication of pests and diseases and parasitic weeds.

7. CROP ROTATION

- Growing different crops on a piece of land in particular sequence every year.
- Factors affecting crop rotation include climate, soil type, and amount of land, capital, labour available and management ability.
- Principle to follow when selecting allocating crops to plots are:
  - (i) Alternating deep rooted crops with shallow rooted crops.
  - (ii) Alternating leguminous crops with non leguminous crops.
  - (iii) Alternating heavy feeders with light feeders.
  - (iv) Resistant crops to specific diseases with susceptible diseases.
  - (v) Good soil cover crops with poor cover crops.

Advantages	Disadvantage
➢ Full use of soil nutrients from different layers ➢ Control pests and diseases by breaking their lifecycles. ➢ Controls parasitic weeds. ➢ Controls soil erosion. ➢ Even distribution of labour demand throughout the year. ➢ Spreads out financial risks.	➢ Less farm income compared to monoculture. ➢ Need more land ➢ Need more labour. ➢ Requires skill in management.

8. NO-TILL CROPPING (ZERO TILLAGE OR MINIMUM TILLAGE)

Land is cleared but soil is left undisturbed, not tilled or ridged except when making planting holes.

Advantages	Disadvantage
➢ Reduces soil erosion.	➢ Expensive to control weeds with herbicides.

➢ Saves labour – no ploughing or ridging. ➢ Saves money– no machinery. ➢ Effective on hilly areas which cannot be mechanised.	➢ Low production in clay soils which require opening up.

9. BIOLOGICAL FARMING (ORGANIC FARMING OR ECO – FARMING)

➢ Crops are grown using organic inputs e.g. organic manure.
Soils are fertilized using organic manures (farmyard manure, compost or green manure instead of chemical (inorganic) fertilizers. Weeds, pests, and diseases are controlled physically, mechanically, culturally, and biologically, instead of chemical.

Advantages	Disadvantage
➢ Rivers, lakes, aquatic life are not polluted. ➢ Protects useful insects– no use of pesticides/no poisoning. ➢ Improves soil structure through use of manures. ➢ Cheaper to make manures.	➢ Organic inputs are slow in producing results.

FRUIT PRODUCTION: MANGOES

THE IMPORTANCE OF FRUITS

1. Source of raw materials to local industries. Local industries process fruits to manufacture a wide range of products e.g. juices, jams, marmalades, pickles, spiced preserves such as mango achaar e.t.c.
2. They provide people with income after sale.
3. Source of valuable food nutrients such as vitamins and minerals for protecting the human body against diseases.
4. They provide employment to people working in the orchard and other people engaged in marketing of fruits.
5. Source of foreign currency.

VARIETIES OF MANGOES

➢ Common local varieties include: boloma, Domasi, Waka, Kapantha and Kambalata.
➢ Common exotic varieties include: Haden, Zill, Irwin, Davis-Haden, Palmer, Kent, Keitt and Anderson.
➢ Mango varieties for export need to be well coloured (red or purple blush) and completely fibreless.
➢ Suitable characteristics to look for mango varieties to grow in an orchard are high yielding, early maturity or late than existing varieties in order to extend the mango season.

CULTIVATING MANGOES

(a) Environmental requirements

➢ Deep, fertile, well-drained sandy loam soils optimum pH 5.5-7.5.
➢ Altitude below 600m.
➢ Minimum rainfall of 650mm per annum and a dry period for flowering and fruiting. Rainfall during flowering reduces yield.

(b) Land preparation

➢ Planting holes 90cm× 90cm ×90cm should be prepared two months in advance. They should be refilled with top soil mixed with 5-10kg of well decomposed manure.
➢ Planting holes should be spaced at 9m×9m or 10.5m ×10.5m or 12m×12m depending on the variety and fertility of the soil. The more fertile the soil, the wider the spacing.

(c) Planting

- Sowing or transplanting should be done at the beginning of the rainy season (December or January) for successful establishment.
- If the seedlings are transplanted, cover them up to the collar mark and watering should be done immediately during the first year whenever necessary. Use the sub-soil left from the planting holes to make basins around each tree to hold water.

(d) Mulching

- Cover the soil around the seedling with dry grass or other vegetative matter to conserve moisture.

(e) Weeding

- Clear all the weeds beneath the seedling or tree regularly by hoeing or slashing if not planted with short growing annual crops.

(f) Fertilizer application

- Apply 5-10kg of manure at the beginning of each rainy season and other inorganic fertilizers such as CAN, Triple super phosphate and Muriate of potash. The amount of fertilizer to apply depends on the age of the tree and on the fertility on the soil.

(g) Harvesting mangoes

- Mango trees bear fruits 4-5 years after planting. The fruits of improved varieties should be harvested when they are physiologically mature.
- Fruits are harvested by hand and collected in a bag. The person harvesting should use ladder or climb the tree to pick the fruits by hand, one by one. Fruits should not fall to the ground, to avoid bruising.
- Improved varieties can yield 200-500 fruits per year. For export, they should be packed in 5kg trays with 12-30 fruits in a single layer.

PESTS OF MANGOES

Pest	Damage	Control
Mango stone weevil	➢ The larva damages the stone (seed). Fruits may fall early or rot, or may have hard white areas inside.	➢ Collecting and burying dropped fruits. ➢ Keeping the orchard clean.
Mango scales	➢ Small flat, oval insects attack the leaves, stems and fruits. They produce honey dew (a sticky liquid)	➢ Spraying dimethoate.
Fruit flies	➢ Flies lay eggs on the fruit. Shiny white maggots hatch and enter the fruits. Fruits change colour before they ripe. Parts of the flesh become liquid.	➢ Collecting and burying fallen fruits ➢ Spraying Fenthion. ➢ Harvesting fruits before ripening.

PESTS OF MANGOES

Diseases	Symptoms	Control
Anthracnose	➢ Discoloration of young leaves (leaf spots) ➢ Premature ripening of fruits. ➢ Black spots on fruits. ➢ Rotting of fruits.	➢ Spraying Benomyl.

Powdery mildew	➢ Shedding of flowers and immature fruits. ➢ White substance appears on the flowers.	➢ Spraying Benomyl.

LIVESTOCK FEEDS AND FEEDING

CLASSES OF FEEDS

- The two main livestock feeds are roughages and concentrates.
- **Roughages** are feeds high in fibre and moisture content but low in protein content e.g. fresh grass or green fodder, silage, hay, star grass, banana leaves, maize stalks and groundnut haulms.
- **Concentrates** are feeds high in protein and carbohydrates but low in moisture and fibre content. They can be classified into energy concentrates (e.g. cereal grains, madeya, wheat meal, sorghum and millet, groundnut meal and Soya meal) and protein concentrates (e.g. bone, meat meal and fish meal)
- In addition to roughages and concentrates animals are also given **mineral and vitamin supplements. These are referred to as additives.**

THE COMPOSITION OF FEED AND THE FUNCTIONS OF THE NUTRIENTS

Livestock need feed nutrients described in the table below:

Nutrient	Function	Source
Carbohydrates (made up of starches and simple sugars)	➢ Provide energy for the body ➢ Excess carbohydrates are stored inform of fats.	➢ Cereals e.g. maize, sorghum, millet, madeya) ➢ Potato vines ➢ Grass ➢ Root tubers such as cassava
Proteins (made up of amino acids)	➢ Essential for body building and repair of worn out tissues. ➢ Essential component of enzymes, hormones and antibodies. ➢ Excess carbohydrates are converted into energy.	➢ Grain legumes (such as beans, Soya beans, groundnuts) ➢ Meat, liver, milk. ➢ Bone and fish meal.
Fats and oils	➢ Provide energy (twice as much as carbohydrates)	➢ Oil seeds such as groundnut and cotton seed. ➢ Soya beans. ➢ Milk, eggs and meat. ➢ Fish meal and bone meal.
Minerals (calcium and phosphorus)	➢ Bone formation ➢ Essential for milk production. ➢ Calcium for egg shells.	➢ Milk ➢ Bone meal ➢ Lime
Magnesium	➢ For healthy bones and teeth ➢ Helps to metabolise carbohydrates.	➢ Milk, cereal grains and leafy vegetables.
Iron	➢ Part of haemoglobin. ➢ Prevents anaemia.	➢ Egg yolk.
Iodine	➢ Essential for the growth of thyroid gland, which produces thyroxin.	➢ Iodised salt.

	➢ Prevents goitrer.	
Copper and cobalt	➢ Form part of haemoglobin and enzymes (cobalt is part of vitamin B12) ➢ Improves appetite in ruminants. ➢ Prevents anaemia. ➢ Maintains blood pressure. ➢ Essential for bile formation.	➢ Salts containing copper and cobalt. ➢ Most vegetables contain copper and cobalt.
Sodium	➢ Maintains blood pressure ➢ Essential for bile formation	➢ Common salt and rock salt.
Manganese	➢ Helps in bone formation and enzymatic reactions. ➢ Essential for metabolism of proteins and carbohydrates.	➢ Most feeds
Chlorine	➢ Part of gastric juice. ➢ Aids digestion.	➢ Common salt and rock salt.
Potassium	➢ Helps in the functioning of the muscles and the heart. ➢ Activates enzymes.	➢ Potassium chloride. ➢ Grass.
Zinc	➢ Helps in enzymatic reactions.	➢ Most feeds
Vitamin A (soluble fat)	➢ Needed for good eyesight and growth. ➢ Essential for prevention of diseases.	➢ Milk, fresh grass, yellow maize, fish and cold liver oil.
Vitamin B (water soluble)	➢ Helps in metabolism of carbohydrates, proteins and fats.	➢ Green vegetables, groundnut meal, creals, fish meal, synthetically made by ruminants through microorganisms in the rumen.
Vitamin C (water soluble)	➢ Important for disease resistance.	➢ Green leafy vegetables ➢ Fruits
Vitamin D (soluble in fat)	➢ Essential for bone formation. ➢ Prevents rickets in animals.	➢ Sunlight, fish liver oil, yeast, green grass and hay.
Vitamin E (water soluble)	➢ Essential for the proper functioning of the reproductive system–prevents sterility in male animals.	➢ Cereal grains, Soya beans, grass, groundnut oils, green vegetables, green grass and green fodder.
Vitamin K (fat soluble)	➢ Essential for blood clotting-prevents bleeding.	➢ All leaf especially succulent roughages and leafy vegetables.
Water	➢ Essential for body fluids and maintenance of the shape of the body. ➢ Helps transport nutrients.	➢ Drinking water

FEED RATIONS

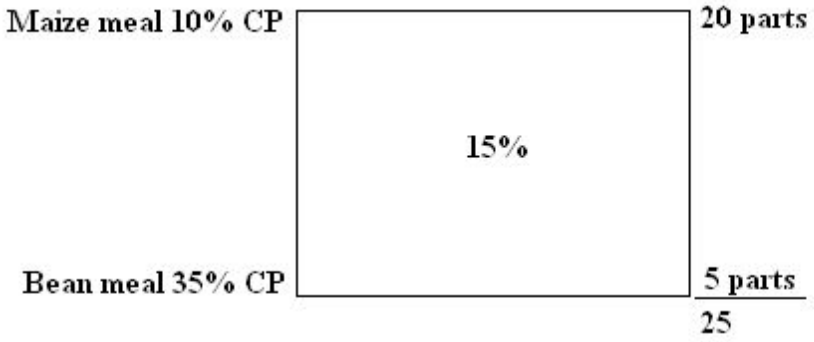
- A ration is amount of feed that an animal needs per day.
- Feed that contains all the nutrients in the right proportions is called a balanced ration.
- There are two main types of feed rations namely maintenance ration and production ration.
- **Maintenance ration** refers to amount of feed that the animal needs per day to maintain its bodily processes without gaining or loosing weight. It is particularly important for young growing animals and animals on gestation.
- **Production ration** is the amount of feed given to animals over and above the maintenance ration essential for animals to produce eggs, meat and milk.

FORMULATING RATIONS USING A PEARSON SQUARE

Example: Formulate a 150kg feed 15% protein containing maize meal 10% protein and bean meal 35% protein.

Procedure

1. Draw a square and place the desired % protein in the centre.
2. Place the % of each feed stuff to be mixed in the left corners.
3. Subtract the figures diagonally across the square.
4. Place the numbers obtained on the left corners.



$$\text{Maize meal} = \frac{20}{25} \times 150\text{kg}$$
$$= 120\text{kg}$$
$$\text{Bean meal} = \frac{5}{25} \times 150\text{kg}$$
$$= 30\text{kg}$$

FACTORS TO CONSIDER WHEN FEEDING ANIMALS

(a) **Age of the animal.**
- Very young animals require less feed than larger animals. Young animals require more energy for maintenance than animals thus consume more food per unit weight.

(b) **The type of animal**
- Ruminant animal can digest roughages while most non ruminant animals cannot. Exotic breeds require good quality feed to produce high yields than indigenous breeds.

(c) Level of production or p **urpose for which animals are kept.**
- Draught animals require high energy feed while animals which produce milk, meat and eggs need concentrates.

(d) **The physiological condition of the animal.**
- Pregnancy, health status and highly starved animals need a lot of feed.

(e) **The quality of the feed.**
- The feed should be easy to ingest and digest.

(f) **Palatability**
- The feed should be appetizing to animals with good taste and smell.

(g) **Digestibility**
- Refers to the ability of the feed to be digested by an animal. This will depend on whether the animal is ruminant or non-ruminant

(h) **Texture**
- Refers to the coarseness or fineness of the feed. Chickens for example prefer coarse feed.

(i) **Cost of the feed**
- A farmer should ensure that feed is given to animals that are in production. For instance it will be unprofitable for the farmers to give layers marsh when they are not laying.

SHEEP AND GOAT PRODUCTION

IMPORTANCE OF SHEEP AND GOATS

1. Sheep provide meat, wool, and skins.
2. Goats provide meat, milk and skins.
3. They are source of income.
4. They provide manure for crop production.

EXAMPLES OF SHEEP AND GOATS FOUND IN MALAWI

Type of animal	Exotic breeds	Indigenous breeds
Sheep	Malawi sheep (fat-tailed)	Black head Persian Merino Karakul Dorper
Goats	Malawi goat Small East African goat	Angora British Saanen British Alpine Toggenburg Boer goat

NB: Local sheep and goats are small, they grow slowly and their yield is low.

BREEDS OF SHEEEP AND GOATS AND THEIR USES

Type of animal	Exotic breeds	Purpose for breeding
Sheep	Black-headed Persian Dorper Merino Karakul	Mutton (meat) Mutton Wool Skin (pelt)
Goats	Angora goat British Saanen Anglo-Nubian goat British Alpine Toggenburg Boer goat	Mohair Milk Milk,meat Milk Milk Meat

CRITERIA USED TO SELECT A BREED OF SHEEP

(a) The primary use of the product.

- Select a sheep that will give the highest production of mutton, wool or pelt (skin).
- The characteristics to look for in a mutton sheep are:
  - (i) Good mothering ability of ewes.
  - (ii) Should be fast growing and mature
  - (iii) Body shape
  - (iv) Body weight
  - (v) Quality of mutton produced

(b) Adaptation to climatic and local environmental conditions.

- The breeds of sheep selected should be adapted to the local conditions e.g. Malawi sheep is hardy and quite adaptable (it requires low inputs)

SHEEP MANAGEMENT

BREEDING

- Only health ewes (young female sheep) and rams (male sheep) should be selected.
- It is also advisable to crossbreed local with exotic to improve production.
- Ewes can be served (mated) when they are 18-24 months old.
- Rams can be used for breeding when they are 8 months old.
- Rams are not allowed to move together with the ewes during mating times to avoid inbreeding.
- One ram can serve up to 60 ewes.
- Rams not recommended for breeding should be castrated.

Reasons for castration

(i) Castrated animals fatten up quickly and produce quality meat.
(ii) It prevents animals from mating and passing on undesirable characteristics.
(iii) It makes animals more docile (easy to handle)

Methods of castration

(i) Using burdizzo to crush the spermatic cords and should be done when animals are about 2-3 months.
(ii) Using a sharp knife to cut the scrotum open and remove the testes.
(iii) Using a strong rubber band or elastrator to cut off blood supply to the testicles.

NB: Breeding should be properly timed so that lambing takes place when there is plenty of grass i.e mating should be done in November so that lambing takes place in April or early May.

OESTRUS

- This is the recurring time of sexual receptivity in female animals also called **heat period.**
- It may occur when the sheep is 6-10months old.
- It may occur between 15-19 days and lasts 18-24 hours.
- Two weeks before the ewes are mated, they should be given some concentrates to improve their health and fertility. This is known as **flushing.**

GESTATION

- It lasts 150 days.
- During this period, the animals should be drenched against internal parasites and vaccinated against diseases. They should also be given some concentrates 1-2 months before lambing. This called **steaming up.**

LAMBING AND CARING FOR LAMBS

Signs of giving birth (parturition)

(i) The sheep becomes restless.
(ii) It leaves the rest of the flock to search for a quite place.
(iii) The vulva becomes red.
(iv) There is frequent bleating.

- When these signs are observed, the ewes should be moved to a lambing paddock. After birth, lambs should be allowed to suckle up to 6 months.

OTHER MANAGEMENT PRACTICES

Castration

- This is the removal of testes from the scrotum. It should be done after one or two months.

Docking

- This is cutting of the tail and is done for the following reasons:
  (i) It prevents dirt and dung from collecting under the tail, which could otherwise be a source of infection.

(ii) It helps in parasite control e.g. makes it easy to remove external parasites, such as ticks, from the anal area.
(iii) In fat-tailed sheep, docking helps to improve the quality of the carcass.
(iv) It helps animals to mate easily.

Trimming

- Cutting back overgrown hooves to prevent lameness.

HOUSING

- The following are the characteristics of a good house for sheep:
  (i) Be strongly built to prevent predators.
  (ii) Have enough space.
  (iii) Be well-ventilated and well-lit.
  (iv) Be dry and warm.
  (v) Be easy and cheap to construct.

FEEDING SHEEP

- They mostly depend on pasture or grass.
- Supplementary feeds such as madeya should also be given.
- Mineral licks of bone meal and salt should also be provided.
- The growth of lambs can be improved through **creep feeding**. This is the practice of giving extra feed in places which are inaccessible to the ewes.

DISEASES AND PARASITE CONTROL

- Some of the diseases and parasites of sheep are shown in the table below:

Disease	Causal organism	Symptoms	Treatment/control
Pneumonia	Bacteria or virus	➢ Loss of appetite ➢ Coughing ➢ Difficulty in breathing ➢ Nasal discharges	➢ Treat with antibiotics ➢ Keep animals in a clean, warm ventilated house ➢ Provide plenty of water and palatable feed
Pulpy kidney or lamb dysentry	bacteria	➢ Staring eyes ➢ Tiredness ➢ Brownish and brown stained diarrhea ➢ Convulsions and sudden death in severe cases	➢ Vaccinate animals.
Heart water	protozoa transmitted by ticks	➢ Loss of appetite ➢ High fever ➢ Nervousness ➢ Animals walk in circles or hit against objects ➢ High death rate in exotic breeds	➢ Dipping ➢ Treat with tetracycline in the early stages
Brucellosis (contagious abortion)	bacteria	➢ Uterus is infected and	➢ Slaughter and burn infected

		foetus dies ➢ Abortion	animals ➢ Vaccination
Foot rot	Fungi, bacteria	➢ Feet swells and animals have difficulty in walking ➢ Feet have pus and a bad smell ➢ Animals may become lame	➢ Treat with antibiotics or disinfectants ➢ Trimming hooves
Foot and mouth	virus	➢ High fever ➢ Dullness in animals ➢ Excessive salivation ➢ lameness	➢ Restrict movement ➢ Vaccinate ➢ Slaughter and burn infected animals
Mastitis	bacteria	➢ Swollen udder ➢ Clots (blood and pus) in milk	➢ Use of antibiotics ➢ Cleanliness during milking ➢ Use of disinfectants ➢ Vaccinate
Sheep pox	virus	➢ High fever ➢ Dark-red pimples ➢ Death of some lambs	➢ No treatment

GOAT MANAGEMENT

- The two main systems of managing goats are tethering and extensive systems.
- Under tethering animals are allowed to graze a restricted area. Goats are tethered where there is limited land and to protect crops.
- Under extensive system of management, goats are free to graze and browse natural pastures, trees and shrubs under the supervision of the herder.

FACTORS TO CONSIDER WHEN SELECTING AN APPROPRIATE BREED OF GOAT

(i) The primary use or the product.

Goats kept for meat production should: grow fast and mature early, be from nannies with good mothering ability, have good body shape.

Milk goats should have large well developed udders.

(ii) Suitability of the breed to local and economic environment

(iii) Personal preference. Most Malawians consider the local goat meat to be tender and tasty. The milk from the local goat is also easy to digest.

BREEDING GOATS

- Female goats (does or nannies) should be served when they are 15-18 months old while male goats (bucks or billies) should be used when they are to years old.
- One billy can service up to 60 nannies.

THE OESTRUS CYCLE

- The length is 18-21 days and occurs for one to three days.

SIGNS OF HEAT IN GOATS

(i) The doe frequently wags her tail.
(ii) She shows signs of excitement.
(iii) She sometimes mounts other nannies.
(iv) The vulva becomes red and thick.
(v) There is mucous discharge from the vulva.

GESTATION PERIOD

- The gestation period is 150 days and the process of giving birth is called **kidding.**

CARING FOR KIDS

- The kids must suckle the mother for at least 3-4 days to get **colostrum** (the first yellow milk rich in vitamins and proteins). It also contains antibodies which are essential for providing immunity to the young one.
- The kids are introduced to some pastures and feed supplements about three weeks after birth to help them develop their digestive system.
- Male kids should be castrated at the same time.

HOUSING GOATS

- The type of house provided for goats will depend on the system of management the farmer uses (extensive, semi-intensive and intensive systems)
- A good goat house has the following characteristics:

(i)
(ii) Well-sited (on high ground)
(iii) Cheap to construct
(iv) Strongly built
(v) Roomy for subdivision into separate types of animals such as milking does, does about to kid, kids, bucks
(vi) Well-lit
(vii) Well-ventilated and dry
(viii) Made of concrete floor or hardened with earth or clay
(ix) Well-thatched
(x) Well-drained and easy to clean

FEEDING GOATS

- Goats are more browsers than grazers. They like tree leaves, bucks, shoots and twigs from trees, shrubs and herbs.
- For high-quality production of meat or milk, goats need supplementary feeds in the form of concentrates e.g. maize meal, madeya, rice hulls, groundnut, cotton seed cake, cow peas and pigeon peas.
- In addition to roughages and concentrates goats should be given plenty of fresh clean water. Goats will not eat soiled feed or drink dirty water.

Good nutrition can be achieved through

a. free range (in paddocks or free area grazed for 2 to 3 months),
b. herding(under supervision),
c. tethering (with a chain and a pin)
d. stall feeding or zero grazing (intensively fed indoors)

PARASITE AND DISEASE CONTROL

- Most of the diseases that affect sheep will also attack goats. There is need to watch out for the following diseases in goats: enterotoxaemia, pneumonia, mastitis, rinderpest, foot and mouth disease and foot rot.
- Good nutrition and management tend to increase disease resistant inn goats and other animals.
- Malawian goats are disease resistant but they can be carriers of internal and external parasites for other animals.
- They should be dipped, dusted or drenched (dosed) to control external parasites (fleas, ticks and tsetse flies) and internal parasites like roundworms, tapeworms and liver flukes.

EFFECTS OF PARASITES ON SHEEP AND GOATS

a. Some parasites compete with their host for food nutrients, in the case of tapeworms and roundworms.
b. Some parasites pierce through and lay eggs in the skin of the host causing damages to the skin and predisposing the host to other infections like sheep mites.
c. Some parasites feed on the body tissue of the host, such as blood sucking worms and protozoa such as trypanosomes.
d. Some parasites such as tapeworm, cause mechanical obstruction of internal digestive passages.
e. Some parasites act as vectors of some diseases. For example, ticks feed on the blood of animals and in the process transmit various diseases such as Anaplasmosis.
f. Some parasites cause inflammatory reactions in their host causing irritation, and in extreme cases, death like lungworms, liver flukes and mites.

GENERAL SYMPTOMS OF PARASITIC ATTACK ON LIVESTOCK

1. General emaciation (thinness)
2. Slow live weight gain, even under proper feeding, resulting in retarded growth.
3. Rough hair coat
4. Pot-bellied
5. Swelling in the jaw region
6. In case of blood sucking worms such as tapeworms, animals suffer from anaemia, diarrhea, loss of appetite and in severe cases death.
7. Presence of the parasites on the body of the host.

MARKETING FORCES

- The price of a commodity at a perfect market is determined by the forces of **demand** and **supply.**
- The higher the price, the lower the demand and the lower the price, the higher the demand.
- On the other hand the higher the price, greater the supply and the lower the price the greater the supply.
- The point whereby quantity demanded is equal to quantity supplied is called **equilibrium point.**

CAUSES OF CHANGES IN THE PRICE OF A COMMODITY

1. Production costs

- This can make the price rise due to the rise in the price of inputs. It might also decrease due to use of improved low –cost technology or government incentives to farmers.

2. Product modification

- The farmer will add substances (additives) to satisfy customers and this will eventually raise the price of a commodity.

3. Attracting customers

- This is made to build up demand and increased sales.

4. Competitors ' prices

- The price may be lowered to match or even drive out other competitors out of the market.

PRICE ELATICITY OF DEMAND

- This is the degree to which demand of a product responds to change in its price. It is the sensitivity of demand to change in price or degree of responsiveness of demand to change in price.

$$edp = \frac{\%\text{ change in quantity demanded}}{\%\text{ change in price}}$$

$E_d = \frac{\Delta Q}{\Delta P} * \frac{P}{Q}$ where ΔQ is change in quantity demanded, ΔP is change in price P the original price before the change Q is the original quantity demanded before change

Example: Determine the price elasticity of demand for beef when the price changes from K100/kg to 110kg resulting in change in the quantity demanded from 5600kg to 4800kg.

$$edp = \frac{\%\text{ change in quantity demanded}}{\%\text{ change in price}}$$

$$\%\text{change in quantity demanded} = \frac{(\text{original quantity} - \text{new quantity}) \times 100}{\text{Original quantity}}$$

$$= \frac{(5600 - 4800) \times 100}{5600}$$

$$= \frac{800 \times 100}{5600}$$

$$= 14\ {}^{2}/_{7}$$

$$\%\text{change in price} = \frac{(\text{original quantity} - \text{new quantity}) \times 100}{\text{Original quantity}}$$

$$= \frac{(100 - 110) \times 100}{100}$$

$$= 10$$

Price elasticity of demand = $14\ {}^{2}/_{7} \div 10 = 1.43$

DEGREES OF PRICE ELASTICY OF DEMAND

(a) Elastic demand (very responsive) (greater than 1)

- This is where a small change in the price causes a large change in the quantity demanded. Luxury commodities like beef tend to have elastic demand because consumers survive without such products.

(b) Inelastic demand (not responsive) (less than 1)

- This is where a change in the price has little or no response or a noticeable change in quantity demand. This is true of staple or basic commodities (necessities) or products that do not have many substitutes such as maize.

(c) Unitary demand (responding on one-to-one basis) (equal to one)

- This is where a change in price of the commodity results in a proportionate change in the quantity demanded. This is true of commodities that are fairly important to consumers e.g. beans, sweet potatoes.

PRICE ELACTICITY OF SUPPLY (esp)

- It is the extent to which the supply of a commodity changes as a result of a change in the price of a commodity. It is the sensitivity of supply to change in price or degree of responsiveness of supply to change in price.
- Mathematically it is calculated as:

esp. = $\frac{\%\text{ change in quantity supplied}}{\%\text{ change in price}}$

Es = $\frac{\Delta Q}{\Delta P} * \frac{P}{Q}$ where ΔQ = change in quantity supplied, ΔP = change in price, P = the initial price, Q = initial quantity supplied

Question

Calculate the price elasticity of supply for groundnuts at Liwonde Market when the price changes from MK90.00 to MK100.00 per kg, resulting in a change in the quantity supplied from 6000kg to 6600kg.

SIGNIFICANCE OF THE DIFFERENT DEGREES OF PRICE ELASTICITY OF SUPPLY

(a) Elastic supply (>1) the change in supply is more than one.

- This shows that a change in the price of a commodity results in more than a proportionate (larger) change in the quantity supplied. The supply curve is less steep. This is true of tobacco whose quantity is increased if farmers were offered good prices in the previous year.

(b) Inelastic supply (<1) the change in supply is less than one.

- This is where a change in the price of a product causes a less proportionate (smaller) change in the supply. The supply curve is very steep. Maize is a good example of a commodity whose supply is inelastic because it is a staple food.

(c) Unitary

- This is where the change on the price is directly proportional (one to one basis) to the supply. The supply curve is a straight line and cuts both axes at an angle of 45^0.

THE DIFFERENCES BETWEEN ELASTICITY OF DEMAND AND ELASTICITY OF SUPPLY

Elasticity of Demand	Elasticity of Supply
When the price rises the demand increases, ie the consumers decline to buy more when the price rises	When the price rises the supply increases ie. The suppliers will be willing to supply more when the prices are favourable.
The response of demand to an increase in price is higher than the response due to a decrease in price.	The response of supply to an increase in price is higher than the response due to a decrease in price.
The response to change in price is immediate because the market forces and commodities are readily available.	The response to changes in price takes long because of the long duration of production.

MARKETING CHANNELS AND AGENCIES

- Marketing involves transferring of goods and services from producers to consumers. It also involves all the processes involved in the transformation and flow of goods and services from the farm to the consumer.
- Marketing channel is a route through which farm produce moves from the point of production (farmer) to point of consumption (consumer).

  Activities in the Marketing channels

  i. Buying and assembling of produce in stores
  ii. Selling. The presentation of the product to the consumer for eventual buying.

iii. Transportation and distribution which ensures consumers get the produce at the right time and within easy reach. The physical movement of the products from one point to another such as
   a. Buying centres to the factory for processing.
   b. Buying centres to the consumers within or outside the country.
   c. Processing factories to the wholesalers or retailers.

(ii) Packing by putting produce in containers such as sacks, crates, boxes, or baskets to facilitate transportation, protects against damage or bad weather conditions, prevents theft and assist in quantification into appropriate amounts for easy handling.

(iii) Storage to ensure availability of the produce between harvests harvest season, by protecting it against damage by pest and from deterioration due to bad weather.

(iv) Processing by changing the state of a product into a more acceptable or usable form such as hides into leather. It also increases the shelf life thereby providing availability of variety of forms such as fresh meat or canned meat.

(v) Grading and standardization makes it easy to assign a price tag. Grading also ensures consumers to buy quality preferred.

(vi) Advertisement by informing, stimulating, educating consumer on products availability as well as persuading consumer to buy product a t the expencse of competing products.

(vii) Packaging by wrapping the produce to ease transportation and keep it safe from contamination.

(viii) Collection and analysis of market information by gathering information on the market.

(ix) Financing through capital to finance all the markets functions.

(x) Risk bearing through the purchase of insurance premiums.

TYPES OF MARKETING CHANNELS

1. Direct marketing channel / one tier marketing channel producer _____ consumer

- This is where a farmer sells their produce to numerous buyers one one-one basis. Tomatoes and cabbage. The advantage is that the consumer and the producer exchange the commodity at a price that satisfy both of them.

2. Indirect marketing channels

- This is where farmers use middle men (intermediaries) to get the production to the final consumer.
- Indirect marketing channels can be two-tier or three-tier.

(i) Two-tier marketing channels. Producer _____middleman_____consumer

- This is where a farmer sells products to one middleperson who in turn sells to several final consumers. Middle persons are active in the selling of goat and fruits.

(ii) Three-tier marketing channel producer _____middleman ____ wholesaler _____consumer

- This is where the two-tier has been lengthened by adding another stage e.g. the wholesaler.
- This eases concentration of final consumers (buyers).

Iii Four tier Marketing channel. Itinerant traders buy produce from the farmer and sell them to the wholesalers, who then sell to the retailers and latter sells goods to consumers.

Producer _____ Itenerant trader _____ Wholesaler _____ Retailers _____ consumer

MARKETING AGENCIES

- These are individuals, companies or organizations that carryout various marketing functions. These can be selling and buying, grading and standardization, assembling, transportation etc.

ROLES OF MARKETING AGENCIES

1. Producers

- This is the starting point of the marketing channel where the farmer sells his/her own products.

2. Itinerant traders:

- These are roving agents who travel to various farms to buy farm produce, which they may assemble and transport to wholesalers or retailers or processors.

3. Middlemen

- These are people who form a link between the producer and the consumer. They fulfill a number of roles:
  - (i) They link producers and consumers who may be far apart.
  - (ii) They assemble the produce from tiny scattered farms.
  - (iii) They have the financial capacity to buy the produce from farmers or even give loans for production.
  - (iv) They have transport facilities to collect and move the product from the point of production ton point of consumption.
  - (v) They build up the bulk of produce at a greater risk of price fluctuation and possible deterioration due to pests and bad weather.
  - (vi) They have facilities for cleaning and grading produce to improve quality.
- They supply important information to farmers on market tends and prices of inputs.

4. Wholesalers

- These sell goods usually at lower prices in large quantities. Their roles include:

(i) Selling: They provide trained sales force.
(ii) Market research.
(iii) Storage: They provide warehousing facilities.
(iv) Transportation: They provide delivery facilities.
(v) Financing: They give credit to retail or institutional consumers.
(vi) Risk bearing: They take the risks by being responsible for theft or deterioration of goods.

5. Processing companies

- These are private or public companies which buy farm produce as raw materials from farmers to itinerant traders and process the raw materials turning them into finished products. They also advertise their products.

6. Produce marketing co-operatives

- These are associations of people formed to assemble (collect) farm produce from farmers and sell to processing companies or wholesalers.

  Roles of co-operatives.

  a. Carry out all marketing functions on behalf of the farmers
  b. Provide short-term credit facilities to their members in terms of inputs or cash loans payable by the end of the production period.
  c. Negotiate for fair prices for both input purchase and sale of farmers produce.
  d. Distribution of farm inputs to their members.
  e. Provide extension services and machinery hire services and sale of farmers produce.
  f. Advice their members on new and better methods of production.

g. Keep records on all activities of the co-operative and inform the members accordingly
h. Pay dividends to their members
i. Some provide banking services to their members
j. Some invest money on behalf of the farmers.

7. Marketing companies/ boards

- These include such marketing agencies like ADMARC and Press produce Limited.
- Their roles are:
  (i) Pricing agricultural commodities like maize in consultation with government.
  (ii) Selling food crops.
  (iii) Transport farm produce.
  (iv) Risk-bearing.
  (v) Disseminating market information to farmers and consumers.

8. Retailers

- These are marketing agencies involved in the buying of commodities from wholesalers and sell them to the final consumer. Examples are butcheries, supermarkets. Some of the roles are:
  (i) Gathering a variety of commodities.
  (ii) Paying suppliers of commodities before selling them.
  (iii) Storing commodities.
  (iv) Providing information to consumers through advertising.
  (v) Conducting marketing research.
  (vi) Transporting/delivering commodities.

9 **Roles of commission agents and brokers**

Agents are traders who assist in buying or selling of produce at a fee on behalf of producers and buyers; they have specialized knowledge of the market.
Brokers do not handle the goods but negotiate for sales and bring the buyers and sellers together.

MARKETING COSTS AND MARGINS

MARKETING COSTS

- These are expenses incurred by marketing agencies or payments made to marketing agencies for their services in the marketing channel.

SOURCES OF MARKETING COSTS

- Marketing costs arise from various functions performed by different marketing agencies e.g. transporting, assembling, commission (profit), grading and so on.

A cost is the price paid for goods and services used in the production process. It is the charge (expenses) made for many marketing activities like assembling, transport, storage, grading, processing, wholesaling, and retailing

TYPES OF COSTS

i) **Fixed costs (FC).** These are costs of inputs which do not vary with the level of production such as rent of land, depreciation of machinery, and salaries of permanent labourers.
ii) **Variable costs (VC).** Costs of inputs which vary with the level of production such as cost of feeds, cost of fuel, cost of fertilizers, and wages of casual labour.
iii) **Total costs (TC).** The sum total of all fixed costs (FC) and all variable costs (VC). TC = FC + VC.

iv) **Average cost (AC).** Total cost (TC) divided by the number of units of output (Y). AC= TC = FC +VC
Y Y

V **Average Variable Cost (AVC**) The total variable cost divided by the units of output realized. AVC= VC
Y

vi. **Average Fixed Cost. (AFC).** The total fixed cost divided by the number of units of output realized. AFC= FC
Y

vii. **Average Total Cost (ATC).** Sum of average variable cost and average fixed costs. **ATC = AVC + AFC**

viii. **Marginal Cost (MC**). The extra cost incurred in the production of an additional unit of output. It is indicated by the change in variable cost divided by the change in output (Y).

MC = change in VC = Δ VC where Δ (delta) means change.
Change in Y Δ Y

MARKETING MARGINS

- This is the difference between the cost of the produce (from the farmer) and selling it to the consumer. It is calculated as follows:

  Marketing margin = Retail price – Farm gate price

- The marketing margin and the marketing costs are the same: the total marketing margin is the sum of the margins at the different stages in the marketing channel, which is the same as the total marketing costs. Therefore.

  Marketing margin = Marketing cost.

REDUCING MARKETING MARGINS

- Reducing the marketing margin will help to increase the farmers ' share of the product value who toil a lot for commodities to be produced.
- Some of the ways of reducing marketing margins are:
  (i) Raising prices of farm produce.
  (ii) Performing some of the marketing functions like grading.
  (iii) Eliminating some of the marketing functions e.g. grading of beans can be avoided if pure seeds were sown.
  (iv) Skipping some marketing agencies. The farmer can sell directly to the wholesaler or even consumer and reap all the profits.
  (v) Selling through a cooperative for more bargaining power since it is a group.
  (vi) Reducing consumer prices at retail level. This can be done through bodies like Consumers Association of Malawi (CAMA).

Exercise

Given the following information on marketing costs of mangoes at different levels in a marketing channel:

- transport costs for a retailer K250.00
- displaying costs for a retailer K150.00
- storage costs for the retailer K400.00
- retailer 's profit K600.00
- transport cost for an itinerant trader K400.00
- itinerant trader 's profit K500.00

- marketing price at the farm K1000.00
- grading costs for the wholesaler K200.00
- storage costs for the wholesaler K400.00
- wholesaler 's profit K500.00

(i) Calculate the price received by the itinerant trader.
(ii) Calculate the percentage share of the product value for the wholesaler.
(iii) Calculate the marketing margin for the mangoes.

POPULATION DISTRIBUTION AND MARKETING

- This is the settlement of people in an area.
- The population distribution of a country can be described based on the following elements: location, education, income, age, gender and occupation.

THE EFFECTS OF POPULATION ON MARKETING.

1. PLACE

(i) It affects the direction of flow of commodities. Areas with large population like urban areas are attractive markets since most of the people are consumers.
(ii) It affects the length of the marketing channel. Direct channels are common in areas with low populations.
(iii) It affects the method of transporting the product to consumers. In areas with low populations, people carry their produces on either heads or bicycles.

2. PRODUCT

(i) It affects the quantity of products required. Areas with high populations generally have more customers and therefore require more supplies of goods unlike low populated areas.
(ii) It affects the quality of the product offered in the market. The multitude of customers in highly populated areas means that some of them pay well for better quality products.
(iii) It affects the range and form of products in the market. Larger populated areas like cities and towns require a wide variety of goods in various forms. This need encourages marketing to perform its processing role in order to supply the products in the form required by different consumers.

3. PRICE

(i) It affects demand for marketing services. In urban areas there are many marketing services which eventually lead to price rise.
(ii) It affects the supply of marketing services. The high prices for commodities stimulate producers to provide more and more. Later on, the prices might start lowering.

4. PROMOTION

- This covers advertising (product promotion and sales promotion) to persuade customers to buy the product. Promotion

(i) Affects choice of people to target. This promotes market segmentation (dividing the market into groups of consumers who have similar needs).
(ii) Affects the types of advertising methods used. In highly populated areas, the mass media, trade fairs and exhibitions or agricultural shows are more common. In rural areas it involves personal selling.

FARM RECORDS AND ACCOUNTS

- Farm records are documents which remind the farmer about the various activities done as they grow crops and raise animals on the farm.

IMPORTANCE OF FARM RECORDS

- They help farmers:

(i) To know the timing of various farming activities e.g. land preparation, sowing, fertilizer application.
(ii) Provide a history of what has been happening on the farm.
(iii) To know when to breed animals.
(iv) To know when to cull (removing unproductive animals)
(v) They help farmers in farm planning i.e. in deciding what, when, how and where to produce and the type of rotation to follow. The farmer can also decide whether to increase or reduce the size of farm enterprises.
(vi) To budget by assisting in finding the expected income and costs.
(vii) To keep an accurate record of financial transactions thereby in detecting fraud or losses.
(viii) To compare production practices within the farm itself and other farmers.
(ix) As a requirement by financial institutions to obtain credit loans from money lenders who assess whether a farmer can benefit from a credit.
(x) To determine profits and losses in order to know whether business should be expanded or discontinued.
(xi) Helps in settling insurance claims in case of fire or any other accident.
(xii) Help in providing labour information such as terminal benefits.
(xiii) To select the type of livestock to keep after the comparisons.
(xiv) Help in settling disputes in a joint business if one partner dies.
(xv) Help in the proper management of various routine livestock or crop production practice
(xvi) To calculate the amount of tax that they have to pay thereby avoiding over-taxation.

TYPES OF FARM RECORDS

1. **Breeding records.** Show details about the breeding programs of the livestock containing mating and parturition dates, animals used for breeding, age of the animal
2. **Feeding records.** Show type of feeds, balance of feed, number of animals, enterprise name.
3. **Production records.** Show amount of produce (yield) by various animals including milk, eggs, crops and honey.

- They are used to record operations or activities and inputs used in producing a crop or raising an animal and the farm produce or output.
- Examples of production records are: crop production records, field records, livestock production records and labour records.

Crop production record

Type of crop	Plot no./hectarage	Inputs used (seed, manure, fertilizer, weedicide, labour	Yield/output
Maize			
Groundnuts			
Tobacco			
Tomatoes			

Field record

Date	Plot no./crop	Operations/activities	Inputs used (seed, manure, fertilizer, weedicide, labour	Remarks
1/7/2001	1 maize	Land preparation	Casual labour used for two days (4 people ×16 hours @ MK 50.00/day	Ridging completed in two days

10/11/2001	1	Planting	10kg of MH 18 maize	Planting took days because of rain
1/12/2001	1	Weeding	Casual labour used (three people × 24 hours) @ MK50.00/day	Work completed but needed more people
15/12/2001	1	Fertilizer application	2 × 50 kg bags of 23-21-0 + 4S used	The fertilizer was inadequate
30/4/2002	1	Harvesting	Hired six people × 2 days @ MK50.00 /day	50 bags of 50 kg each were harvested

Livestock number record

Class of livestock	No. on hand at the beginning	Bought or received	Born	Total	Slaughtered or died	No. on hand at the end

NB: Labour is an important factor of production and, as such, the farmer should keep labour record. Labour is the actual work done by the people and not the people themselves. It is actually measured in terms of man days. It is estimated that a male can do 25 man days in a month (1 man unit × 25). A female can do 17.5 man days in a month (0.7 man units × 25) and a child can do 7.5 man days in a month (0.3 man units × 25). The estimates take into consideration illness, leisure times and other social activities. Table below is an example of labour record.

4. **Health records.** Shows disease control measures taken such as vaccination dates, treatment dates, drugs used and disease symptoms .
5. **Field operation records.** Shows various operations in crop production which include planting, weeding, harvesting, land preparation and fertilizer application with expected dates for operation.
6. **Labour records.** Shows the types of labour whether family labour and hired labour which can be either casual or permanent. It also shows the allocation of daily duties attendance called a master roll.
7. **Marketing records.** It shows cash analysis, journals and ledgers assist a farmer in easily calculating the income from sales, marketing records help in establishing harvesting trends and markets where produce was sold.
8. **Financial records and accounts**
   These are kept for the farmer to know whether they are making profit or loss. Farmers need to keep more details of all the income and expenses for the farm. Farm managers keep system entries of various activities and transactions carried out within the farm such as a cash book, ledger balance sheet.
9. **Inventory records**

- This is a list of all properties or assets (things that can be converted into cash) that a farmer has on the farm. There are two types of inventories, consumable goods and permanent goods. The best time to do this is at the end of the farming season when there is less work to do. The steps involved are:
  (i) Counting the items physically.
  (ii) Physical measurement e.g. land.
  (iii) Estimating the value using the present marketing prices.
  (iv) NB: When estimating the present value of equipment, it is important to consider **depreciation** (loss of value of the item over time).

TYPES OF DEPRECIATION

A. Straight line depreciation (reducing the value by 10% per annum)

- For example an equipment bought at MK20,000 that is supposed to last for 10years its straight line depreciation can be calculate as follows:
  Year 1: MK20, 000 – 10% = MK20, 000 – MK2000 = MK18, 000
  Year 2: the value will be MK18, 000 – MK1, 800 = MK16, 200, and so on.

B. Fixed rate (declining balance) depreciation i.e. reducing the value by 20%b per annum.

- For instant in the above example, the value in year 1 will be MK20, 000 – MK4, 000 = MK16000 and in year 2 will be MK16,000 – MK3,200 = Mk12,800 and so on.

3.

- In addition, they should keep a record of farm produce used in the home. This is important because the value of the produce does not appear under the sales and receipts and hence does not give a true picture of the output from the farm, so the profit will be underestimated. The produce used in the home should therefore be valued using current market prices.
- Table below shows how a financial record looks like.

Sales and receipts			**Purchases and expenses**		
Date	**Details**	**MK T**	**Date**	**Details**	**MK T**
2/3/2001	30 units eggs @ MK7.00	210. 00	1/3/2001	1 bag layers mash	800.00
5/4/2001	vegetables	50. 00	1/1/2001	2 bags manure	50.00
10/2/2001	6 bags of maize	1500.00	6/12/2000	2 bags CAN	2000.00
12/8/2001	3 bags cassava	600.00			
15/9/2001	5 bags groundnuts	1500.00			
	Total receipts	**3860.00**		**Total expenses**	**2850.00**
				Profit	**1010.00**
		3860.00		**To balance**	**3860.00**

ENTERPRISE COMBINATION

It is a relationship which shows how different enterprises relate to one another. The relationship helps to determine what to produce and a combination that will give maximum revenue.

FACTORS AFFECTING ENTERPRISE COMBINATION

1. The availability of farming resources

- Farming resources are land, labour, capital and managerial skills.
- **Land:** If the land is small due to population growth, it is difficult to combine enterprises.
- **Labour:** Farmers in tobacco enterprises need a lot of labour. If they are scarce, it negatively affects enterprise combination.
- **Capital:** If there is sufficient capital, the farmer will find it easy to engage in enterprise combination.
- **Managerial ability:** This involves making sound decisions. Combination of enterprises will therefore depend on the farmer 's knowledge of the enterprises involved.

2. The farmer 's food requirements

- A farmer has to priotise food production. Land, labour and capital will need to be spared first for food production before consideration is given to cash crops. Statistics show that an adult

will require an average 300kg of maize per year while a young person under 18 years old will require 150kg of maize per year.

3. Profitability of enterprises

- Farmers need to select those enterprises or their combinations that will give them the highest returns.

4. The nature of enterprises.

- The farmer should choose an optimum enterprise combination that will give the greatest total revenue.
- Enterprises may be competitive, complementary or supplementary.
- **Competitive enterprises:** This is where an increase in one enterprise results in a decrease of the other as they compete for the same resources like land and labour.
- **Supplementary enterprises:** An increase in one product may not lead to a decrease in output of another as they do not compete for resources and in other cases, but one enterprise may benefit from the other like maize benefitting from groundnuts. For example, growing beans in a coffee plantation, beans will not affect the output of coffee.
- **Complementary enterprises:** This is when each contributes to the production of the other such as poultry and vegetable production. For example, intercropping legumes and cereals, forage and daily production.

5. Opportunity cost

- This refers to the return that is given up such as raising animals instead of growing crops or reducing amount of tobacco in preference to maize.
- Farmers should decide on the alternative that will give bring the maximum return or profit.

6. Comparative advantage

- This means concentrating on enterprises that are best suited to the area in terms of soil, climate and nearness to the market.
- It is best for farmers to concentrate on those enterprises or their combinations that can best be produced their area.

7. Risks and uncertainties

- A risk is the difference between what one expects and the actual outcome like price fluctuation while uncertainty is a state of not knowing what will happen in future such as one cannot tell whether there will be drought or not.
- Farmers can safeguard themselves from risk and uncertainties by:

(i) Selecting more reliable enterprises.
(ii) Crop diversification i.e. producing several crops.
(iii) Being flexible in the method of production.
(iv) Practicing input substitution e.g. using manure instead of chemical fertilizers.
(v) Keeping food in reserves to ensure food security in times of bad seasons.
(vi) Insuring crops.

8. The farmer 's abilities

- Farmers need to be conversant with the techniques involved in the enterprise for them to make profit.

9. Changes in price technology

- When new technology is introduced farmers need to evaluate its benefits before adopting it.

Other factors affecting enterprise combination are:

1. The crop rotation to be practiced
2. Expected yield from the enterprise.
3. Its input requirements
4. Expected prices to be offered at the market.

FARM ENERGY

- Farm energy is the capacity of the physical system to do work in the farm.

FORMS OF ENERGY

(i)
(ii) solar
(iii) sound
(iv) electrical
(v) fuel
(vi) light
(vii) mechanical
(viii) wind
(ix) potential
(x) heat
(xi) chemical
(xii) water
(xiii) kinetic

WIND ENERGY

It is harnessed by use of wind mills and used for the following farm operations.

a. Pumping water from boreholes
b. Generating electricity
c. Winnowing crops such as beans, millet, and rice after threshing.

ADVANTAGES

a. It is inexhaustible
b. Equipment has low maintenance costs.
c. No pollutant

DISADVANTAGES

a. Unreliable
b. Its direction cannot be controlled.
c. High initial costs in setting up a windmill
d. It is limited to areas where wind is prevalent

BIOGAS

A flammable gas produced when organic matter is decomposed by micro-organisms within a certain range of temperature, moisture content and acid conditions. Apart from animal waste as the main material, garbage, plant leaves, grasses, crop straws and industrial wastes may be used.

USES OF BIOGAS

a. Heating and cooking
b. Lighting

ADVANTAGES

1. Environment friendly as it uses waste products.
2. Cheap to generate once digester is installed.
3. An excellent source of manure
4. Low maintenance costs

DISADVANTAGES

1. High level skills required for installation

2. Most appropriate with animals under zero grazing
3. Labour intensive
4. Requires large quantities of raw materials
5. Relatively high installation costs
6. Limited to a few farm operations.

WOOD ENERGY

The cheapest and most common source of energy. The demand for wood fuel continues to increase and is leading clearance to forest lands which has contributed to environmental degradation.

USES OF WOOD ENERGY

a. Cooking, heating and lighting
b. g
c. Processing farm produce such as curing of tobacco leaves and smoking fish.

ADVANTAGES

a. It is a cheap source of energy in rural areas.
b. Less skills are required in preparation of charcoal
c. Easily availability in many parts of the country.

DISADVANTAGES

a. Leads to environmental degradation through deforestation, soil erosion, and air pollution.
b. Limited to very few operations in the farm like heating and ng oil only.
c. Smoke contributes to air pollution.

FOSSIL FUELS

They are hydrocarbon compounds that are used to provide power through their combustion like petroleum 's kerosene, petrol and diesel.

USES OF FOSSIL FUELS

a. Ploughing and harrowing
b. Transporting farm produce
c. Spraying of herbicides or pesticides
d. Mowing grass
e. Lighting of homes
f. Pumping water for irrigation

ADVANTAGES

a. High energy output
b. Engine energy increases efficiency and precision in carrying out farm operations
c. Labour saving.

DISADVANTAGES

a. Expensive to produce
b. Some machines may not be used in certain in landscapes like steep slopes.
c. A major pollutant
d. Not renewable.

HYDRO ELECTRIC POWER

Electric energy generated from flowing water that rotates turbines connected to a generator to produce electricity.

ADVANTAGES

a. Environmental friendly as it does not cause pollution
b. Can be used in a variety of farm operations
c. Inexhaustible
d. Cheap to maintain once established

DISADVANTAGES

a. Very costly to generate hydro-electric energy
b. Machines have high maintenance costs.
c. Energy generation is affected by fluctuation of water levels in the rivers.

SOURCES OF ENERGY

- Solar energy is the source of all energy.
- Light energy is transformed into chemical which later become mechanical energy.
- Potential energy is the type of energy stored in matter.
- Kinetic energy is the one that makes objects move and is influenced by the mass and speed of an object.

SOURCES OF ENRGY AND THEIR USES

Source of energy	Uses
Solar	➢ Manufacture of plant food ➢ Drying of crop plants
Water	➢ Producing electricity for domestic and industrial purposes
Fuel	➢ Wood and charcoal for heating, cooking. ➢ Coal for heating and operating locomotives ➢ Petrol and diesel for operating machines and running vehicles ➢ Paraffin for heating and lighting
Biogas	➢ For lighting and heating
Animal draught	➢ For pulling implements and ox-carts used for transportation
Human power	➢ Cultivation ➢ Carrying out domestic and industrial work
Electricity	➢ Lighting, heating, operating grinding mills, pumps for irrigation
Wind	➢ Driving windmills used for and pumping water for irrigation.
Mechanical power	➢ Driving machines for both primary and secondary cultivation

KEEPING SAFE

- It is important to observe safety measures when using sources of energy to avoid accidents that could lead to cuts, burns and even death. Therefore:
  (i) Petroleum products should be handled with great care, as they are highly flammable.
  (ii) Running engines should be switched off when refueling at pumping stations.
  (iii) Do not wear loose clothes when working machines.
  (iv) Electric wires should be treated as live all the time to avoid being electrocuted.
  (v) Wear sun glasses when working in the sun.
  (vi) Keep paraffin away from children.
  (vii) Gases should be carefully handled since they are also highly flammable.
  (viii) Power cables should not be run overhead buildings. No building should be constructed

Under the power cables to prevent accidental fires.

(ix) Use heavy rubber cords which is moisture free when using portable motors and batteries.

(x) Never stay in a room with burning charcoal in a furnace without proper ventilation.

ENERGY SOURCES
HYDRO, FUEL WOOD, FOSSIL, BIO-GAS, WIND ENERGY, SOLAR, IRRIGATION SYSTEMS AND DRAINAGE

The artificial application of water to crops when rains are not sufficient, reliable or available.

CIRCUMSTANCES THAT NEED IRRIGATION

a. Dry areas. When rains inadequate, insufficient for crop production

b. Unavailability of rains/ Long dry periods. Crops such as coffee, tea, citrus fruits, pineapples and vegetables that fetch high prices.

c. Paddy rice. Requires

WHY MALAWI NEEDS IRRIGATION

To have food through-out the year, rains are very unreliable.

IMPORTANCE OF IRRIGATION

d. It eliminates the risk of total crop failure when rains are insufficient, unreliable or unavailable.

e. It enables farmers to grow more than once in a year, thereby increasing the supply of food or raw materials for the processing industry.

f. Can reduce salinity

FACTORS TO CONSIDER WHEN SETTING UP AN IRRIGATION SYSTEM

1. Capital availability.
   - You need to know the amount of capital required to set up the irrigation unit such as purchasing, installation, and maintenance of an irrigation equipment.
2. Source and quality of water.
   - The source should be reliable and adequate throughout. The water should also not contain any toxic (poisonous) substances.
3. Type or topography of land.
   - The land needs to be big enough and sloppy so that water flows easily.
4. Type of soil and crop to be grown.
   - The soil should be suitable for irrigations should be clay soil as it retains water.
   - The type of crop to be grown should be such that it can flourish under irrigation e.g. cotton, tobacco, groundnuts, maize, tea, sugar cane, rice and vegetables.
5. Maintenance.
   - You need to establish how you shall keep the equipment running all the time e.g. removing silt which block irrigation channels.

CHARACTERISTICS OF DIFFERENT IRRIGATION SYSTEMS

System of irrigation	Characteristics

Furrow irrigation	➢ Water is led by gravity along furrows ➢ There are channels between plots and rows of crops. ➢ The ground between the furrows is wet by the water from the furrows. ➢ The system needs a lot of water. ➢ It requires land which is sloping. ➢ Erosion may occur if on a steep slope ➢ Loss of water due evaporation minimized due to sinking of water ➢ It is not economic in the use of water
Flood irrigation	➢ Easiest and cheap as no need for sophisticated structures ➢ Can cause erosion if used on steep slopping land ➢ Improves fertility through alluvial soils ➢ Requires a lot of water ➢ waste a lot of water ➢ Whole area is flooded. ➢ Serious erosion if on a steep slope ➢ Requires heavy clay soils in which water penetrates slowly. ➢ Suitable for crops which can grow in standing water. ➢ The land needs to be level or gentle
Basin irrigation	➢ A type of irrigation where water is diverted to basins. ➢ Suitable for orchards and trees ➢ Conserves water in basin ➢ Easy to control water entering basin ➢ Excessive water may cause rotting of plants
Drip irrigation	➢ Water is conveyed through plastic pipes which may be laid on or underground. ➢ The pipes have small holes. ➢ Uses water economically. ➢ Suitable for areas where water is scarce. ➢ The pipes may be blocked by silt. ➢ Piping may be expensive. ➢ Can be used on sloping land ➢ Does not require much labour once established. ➢ Can be used to control weeds by denying water
Overhead/sprinkler irrigation	➢ Does not require much labour once established. ➢ Can be used on most soils and land with varying slopes. ➢ Requires expensive equipment (pipes and sprinklers) ➢ Prone to vandalism ➢ The amount of water to be applied can be controlled. ➢ It is the most effective method of irrigation. ➢ There may be uneven distribution of water especially on windy day ➢ Sprinkles may be blocked by silt

FACTORS TO CONSIDER WHEN CHOOSING AN IRRIGATION SYSTEM

(i) Amount and source of water available.
(ii) Type and size of land to be irrigated.
(iii) Labour required setting up and managing the system.
(iv) Amount of capital required to set up the system.
(v) Topography (slope) of the land.
(vi) Type of soil and its characteristics.
(vii) Type and value of the crop to be grown.
(viii) Demand for the crop.
(ix) Your technical know –how of a particular irrigation system.

MANAGING AN IRRIGATION SYSTEM

- Aspects of management include frequency and timing of watering and handling problems associated with irrigation (such as salt accumulation and soil erosion)

FACTORS TO CONSIDER WHEN DECIDING FREQUENCY AND TIMING OF WATERING

Amount of rainfall – there is need to irrigate when there is insufficient rainfall.
Amount of water applied during the previous irrigation – this is to avoid loss due to run-off.
Crop requirements – the age and the condition of the crop need to be considered, as young plants require more water than older plants.
Weather conditions – when conditions are humid, not much water is needed since most of it is not lost due to evaporation and transpiration as compared when it is sunny or hot.
Type of soil – clay soil does not require frequent watering because infiltration is not as rapid as in sandy soil.
The condition of the soil – the should be applied so that the crops should not reach a wilting point (where plant roots are unable to absorb any little water available)

PROBLEMS ASSOCIATED WITH IRRIGATION AND THEIR SOLUTIONS

1. Salt accumulation
   - These make the soil saline and most crops do not do well under such conditions. When sodium salts accumulate the soil become alkaline. This can be corrected by flooding with salt-free water.
2. Soil erosion
   - This occurs due to excessive application of water. This can be solved by ensuring that irrigation structures are properly maintained.
3. Blockage of irrigation pipes.
   - This can be solved by maintaining the pipes regularly.
4. Water logging
   - This results from applying too much water. It can be solved by controlling the amount and frequency of irrigation.

FACTORS TO CONSIDER WHEN MANAGING AN IRRIGATION UNIT

- ✓ The value of the crop under irrigation, if the price of produce is high management is also high
- ✓ Level of education of the farmers, as enlightened farmers have higher efficiency
- ✓ Disciplined farmers reduce losses
- ✓ Capital investment requires high standard of management
- ✓ Type of irrigation as technical knowhow for every type differ

LAND DRAINAGE

- This refers to removal of excess water from the soil.

IMPORTANCE OF LAND DRAINAGE

1. It reduces the input of water into the soil.
2. To avoid water lodging which is hazardous to most plants that require little water.
3. It improves soil aeration.
4. It enhances microbial activity.
5. It warms up the soil which enhances seed germination.

EFFECTS OF WATER LOGGING

1. Poor aeration – this makes plant roots fail to respire due to lack of oxygen.

2. Retarded microbial activity – it slows down the decay of organic matter because aerobic microbes are unable to respire.
3. The soil becomes cold and this slows down seed germination.

CAUSES OF POOR DRAINAGE

1. Too much rainfall in flat or low lying areas
2. High amounts of clay particles in the soil which has a high water holding capacity
3. Presence of impermeable rock near the soil.
4. Formation of hard pans in the soil which prevents water percolation into lower soil depths
5. High water table.

METHODS OF LAND DRAINAGE

1. Surface drainage.

- Ditches are constructed to carry the excess water by gravity to a natural waterway such as stream or river.

Advantages

The open ditches are easy to construct.

- Open-ditches have the following disadvantages on the farm:
  (i) They occupy land which would otherwise be used for crop production.
  (ii) They obstruct machinery where mechanization is practiced.
  (iii) They are more expensive to construct.

2. Sub-surface drainage.

- This involves laying porous pipes or ceramic tiles in the ground. The superfluous (excess) water flows through the pipes or tiles and this is led to a natural waterway.

Advantages

- All the land is available for cultivation as porous pipes are laid under the ground
- Machinery moves without problems
- The pipes are cost effective as they stay for a long time without replaced.

Disadvantages

- The pipes or ceramic tiles are very expensive.
- Sediments may block the nozzles hindering effective irrigation.

AGRICULTURAL EXPERIMENTATION

THE SCIENTIFIC APPROACH TO EXPERIMENTATION

- This is a method of testing a hypothesis in order to find out the truth (or establish a fact) through observation (of cause and effect) and to draw conclusions through induction.
- Steps in the scientific approach include:
  1. Identifying a problem or area of study e.g. weeding methods in maize.
  2. Clarifying aims, objectives or an hypothesis in order to be sure of what you want to achieve by attempting to solve the problem e.g. to find out which spacing of MH18 maize gives the highest yield)
  3. Setting up the experiment to test the hypothesis. This involves designing and laying out the experiment in the field.
  4. Collecting information (data) by taking observations and measurements.

5. Analysing observations, measurements and results. This may include calculating averages of measurements taken e.g. the average yield of MH18 maize from each spacing tested in an experiment.
6. Evaluating the results e.g. judging by comparing average yields from different spacings in the above example.
7. Drawing conclusions, that is, deciding on the best spacing of MH18 maize. Any recommendation would depend on this decision or conclusion.

PROBLEMS WHICH CAN BE SOLVED THROUGH EXPERIMENTATION

- Many problems relate to yield quantity and quality. Table below shows some questions with crop production that would be answered by experimentation.

To find out the effect of different	mulching techniques soil textural classes varieties fertilizers fertilizer rates plant populations irrigation rates weeding frequencies weeding methods irrigation methods organic manures seed sizes planting times planting depths herbicides pest control measures box ridging ploughing depth cropping systems fumigation/soil sterilization	on the	yield quantity growth rate leaf area rooting stalk diameter pest score disease incidence yield quality	of	maize groundnuts tomatoes drumhead cabbage onions amaranthus peas carrots mangoes

EXPERIMENTAL DESIGNS

- An experimental design is a plan of how the experiment is going to appear in the field.
- In crops, the experimental area is divided into plots. The different varieties of management (husbandry) practices are assigned one to each plot. The yield and other plant characteristics are measured from each plot. Using measurements comparisons between the varieties are made.
- When designing experiments it is important to consider the choice of treatments, replication and randomization.

CHOICE OF TREATMENTS

- The first step in planning an experiment is to decide what to be studied and the nature of the variables (treatments) to be compared.
- For example, in an experiment to study the effect of different fertilizer rate of Muriate of Potash fertilizer on tomato production, the treatments (variables) whose effect is to be compared may be shown as in the table below.

Treatment	Rate (kg per hectare)
1	0
2	50
3	100

4	150
5	200

- Every field experiment must have two or more treatments. One of the treatments must be a control. A control is a standard treatment against which the rest of the treatments are compared, checked or judged. In order to form a useful basis of comparison, the control must be the treatment most familiar to researchers, or most commonly used in the area.
- For example in the fertilizer experiment described above the control treatment would be fertilizing at the 0kg/ha rate.

RANDOMISATION

- This refers to allocating treatments to plots by chance
- Treatments can be allocated to plots by chance using the following methods:
  1. Tossing a coin where only two treatments are to be compared.
  2. Throwing a dice if there are six treatments.
  3. Using numbered pieces of paper. Each treatment is written on a piece of paper. All the pieces are placed in a container which is shaken. One paper is selected at a time, sat random. The first to be picked is allocated to plot1, the second to plot 2 and so on.
  4. Using random number tables (refer to Strides in Agric Book 3 page 177-178)

REPLICATIONS

- This means repeating field experiments.
- Field experiments can be done twice or more, in different places (blocks). For example, the fertilizer trial can be done in three blocks (replicates) as shown below.

	Block I	**Block II**	**Block III**
Plot 1	T3	T5	T4
Plot 2	T1	T3	T2
Plot 3	T5	T2	T1
Plot 4	T4	T1	T5
Plot 5	T2	T4	T3

- Replication is done to minimize environmental interferences. This is because one treatment appears in each replicate (block). This means average figures will be used for comparison. A superior treatment may perform well in most of the blocks and have a higher average yield. Such a result is more accurate and reliable. If one treatment outperforms the others in all replicates, it will have the highest average yield and its superiority cannot be in doubt.

TYPES OF EXPERIMENTAL DESIGNS

- There many types of experimental designs. Two of them are Randomised Block Design and Latin Square Design.

Questions

1. Make a field plan for an experiment to test six maize varieties (local maize, MH12, MH16, MH18, NSCM 41 and MH17) in three blocks. Use the Randomized Block Design.
2. Draw a field plan to find out the best four spacings (A, B, C and D) for Moneymaker tomato, using a Latin square design.

CONDUCTING AN EXPERIMENT

- This involves carrying out operations or husbandry practices, collecting data or information, recording the data, and analyzing it so that logical conclusions can be made.

Carrying out operations (husbandry practices)

- When conducting an experiment, it is very important that all treatments be handled(managed) equally, except the aspect being tested.
- The management conditions may include all husbandry practices such as planting, weeding, fertilizer application, pesticide application and harvesting. The only practice that will be changed is the variables to be compared.

- Table below gives examples of what can be changed in some experiments:

Experiment	What can be changed
Spacing	Spacing between planting stations or rows
Time of planting	Planting dates
Depth of planting	Depth of planting holes
Amount of fertilizer	Rates of fertilizer applied per ha or per station
Watering	Amount of water irrigation used
Pesticide application	Types of concentrations of chemicals used to control pests

Collecting data

- Two main methods that can be used to collect data in field experiments are:
  a. Direct observations e.g. germination percentage, leaf colour or disease incidence. Observation may include both looking and counting.
  b. Measuring e.g. plant height, leaf area, growth rate e.t.c.
- Any experimental plot has the border crops or border rows (border ridges). The border crops (outer crops) grow in environment greatly influenced by the characteristics of the neighboring plot and other external influences such as wind, pests, diseases, alluvial deposits, dissolved/eroded nutrients and encroaching weeds. These may affect the growth and yield of border crops. The inner crops in the net plot are less affected by border effects. They are therefore considered the true representatives of the treatments in the plot. For this reason observations and measurements are based on the net plot. This means that when harvesting, experimental plots, each net plot must be harvested separately from the gross plot and the yield weighed for comparison.
- Sample plants should be chosen at random for weekly measurements such as plant height (growth rate), leaf area or stalk diameter, because it is not possible to measure all plants even in the net plot in the experiment.

Recording data

- The information collected can be recorded in the form tables, line graphs, pie charts and bar graphs.
- The researcher has to decide whether to present information in the form of a table, pie chart or bar graph. Some information like leaf colour can only be recorded in tabular form.

Analyzing data

- Three important processes in analyzing data are:
  (i) Calculating percentages e.g. germination percentage, survival percentage.
  (ii) Calculating mean or average figures
  (iii) Calculating the range i.e. finding the difference in performance between treatments e.t.c.
- An analysis should provide average figures, percentages or ranges showing the performance of different treatments. These figures should be used to compare and evaluate various treatments.

POPULATION GROWTH AND THE ENVIRONMENT

POPULATION GROWTH AND SOIL EROSION

Soil erosion is the removal of the top layer of soil by running water or wind.

How vegetation prevents soil erosion

a. Plant roots bind the soil, holding it firmly together.
b. Leaves reduce the impact of raindrops, which would otherwise dislodge (break up) the soil particles.
c. Stems reduce the speed of run-off water so that Water flows away slowly enough not to cause erosion.

CHARACTERISTICS OF ERODED AREAS

a. Have thin top soil in gentle slopes
b. Formation of gullies
c. No vegetation in some areas
d. Exposed rocks and stones
e. Not fit for agricultural purposes.

HOW POPULATION GROWTH CAUSES DEFORESTATION/ SOIL EROSION

j. The higher the population the higher demand for settlement, hence land is cleared to build new houses.
k. Large population encourages trade which requires shops, roads, industries, office shops which demand clearing of land to be constructed.
l. The higher the population in an area, the greater the need for the area for clearing forests to open new farms.
m. More animals are raised to meet the rapidly growing population, leading to overgrazing exposing the land to soil erosion.

EFFECTS OF SOIL EROSION

a. Loss of fertile topsoil which contain a lot of humus and nutrients resulting in land barren and too infertile to produce reasonable yields.
b. Reduction in arable hectarage from the gullies, channels, exposing the rock thereby limiting the farmers land for arable cropping.
c. Food insecurity from low crop yields resulting from loss of fertile soil and reduction of arable land.
d. Exposure of plant roots as run-off water flows at high speed exposes the plants roots increasing root lodging thereby decreasing the capacity of roots to absorb nutrients.
e. Pollution of water reservoirs as agro-chemicals are washed away by run-off water and deposited into dams and lakes
f. Silting of water reservoirs from the sediments deposited into rivers, dams and lakes thus filling the space of water.
g. Flooding as a result of silting of water reservoirs hence water overflows as the reservoir can no longer accommodate much water, creating floods.
h. Transmission of soil pests and diseases by run-off water spreading to low-lying farms.
i. Depletion of water resources due to low infiltration that lowers water table and drying up of rivers, wells, lakes and dams.
j. Drought due low infiltration rate from to increased run-off reduces the amount of water evaporation or evapotranspiration to form rain, causing low rainfall or drought.

WAYS OF CONSERVING WATER

1. Dams: These are water reservoirs that are usually built across a river to catch or hold water.
2. Contour ridges/box ridges: These are ridges constructed across the slope so that they trap and hold water allowing it to sink into the soil.

3. Contour bunds: These are broad-based ridges constructed across the slope.
4. Ground cover

IMPORTANCE OF CONSERVING WATER

1. Domestic use
2. For future use like Irrigation when water is scarce

2. Crop production: plants need water for germination, photosynthesis, transpiration and dissolving mineral salts.
3. Hydro-electric power: When water is insufficient, power supply becomes erratic.
4. Livestock use: Farm animals need to drink water everyday.
5. easy pumping to industries and factories, the higher the volume the easier to pump it
6. to reduce damage to crops and trees, where flowing water is directed to a storage facility reducing chance of flooding and damage.

FISH FARMING

- **Fish is an important source of protein. They can also be sold for money.**
- **Water must be conserved during the rain season so that it must be available during the dry season for fish farming.**
- **A well-managed pond of 200 square metres can produce up to 80kg of tilapia ((chambo) that is four tones per hectare per year.**
- **Fish are farm animals. They are housed and fed artificially in trapped water called ponds.**

POPULATION GROWTH AND FOOD SECURITY

- Food security refers to a situation where there is enough food for everyone at all times.
- Food self-sufficiency means the ability to produce one 's own food in adequate quantities without depending on external supplies.

WAYS OF ACHIEVING FOOD SUFFICIENCY

1. Improved farming technology-this means new and better scientific methods of growing crops and raising livestock. It can improve production through:
   (i) Enabling timely completion of critical farm operations.
   (ii) Developing more effective pesticides, fungicides and herbicides and more efficient ways of applying them.
   (iii) Enriching soil fertility through development and proper use of fertilizers.
   (iv) Developing and using better irrigation systems e.g. sprinkler.
2. Improved varieties of plants and animals: These are being bred for disease resistance, fast growth, early maturity and high yield.
3. Good land husbandry: This involves using each piece of land according to its capability.
4. Fair land policies: A fair land policy should encourage equitable land distribution.
5. Good crop husbandry: This includes early land preparation, early planting, timely weeding, correct fertilizer application and pest and disease control for continued or sustainable use without damaging the soil or causing soil erosion.
6. Irrigating crops: This ensures that farmers obtain yields even in times of drought.
7. Good livestock husbandry: This includes proper housing and medication of farm animals to ensure high productivity.
8. Provision of credit facilities to farmers to enable them to purchase farm inputs and prepare the land.
9. Fair pricing policies. Fair input prices to encourage farmers to buy and use them to obtain high yields.

10. Crop diversification: This means growing more than one crop within the same growing season. This can be done through mixed cropping, strip cropping, relay cropping or dimba cropping.
11. Use of appropriate methods like harvesting of fish, a method that will spare the young ones to continue multiplying.
12. Encourage estate food production: Estates can increase food production by:
    (i) Allocating more land and other resources to food crop production.
    (ii) Trainings farmers in food crop production.
    (iii) Providing tenants with farm inputs for food crop production as short term loans.
13. Marketing facilities for Food storage of excess food: This is important by:
    (i) Reducing food spoilage.
    (ii) Ensuring availability of food throughout the year.
14. Changing personal attitudes and practices to avoid destruction of natural resources.

THE ROLE OF ESTATES IN FOOD PRODUCTION

a. Increasing food production
i. Large scale commercial production of food
j. Casual employment to many workers to enable workers to purchase food.
k. Proper storage facilities for the produce minimizing storage losses
l. Provide training to farmers through demonstrations to acquire skills and by working in the farm
m. Employ economies of large scale hence able to produce food at a cheaper cost.
n. Better facilities such as research station to produce crops that are fast maturing, disease resistant, and drought resistant.
b. Training farmers. Provide training and education for farmers through demonstrations, seminars, and hands on training on the farms.

IMPORTANCE OF STORAGE FOR FOOD SECURITY

a. Reduce spoilage like cereals soaked in leaked roof and become poisonous to man.
b. Ensure availability of food throughout the year.
c. Prevent pests from attacking them hence reducing their shelf life and quality.
d. To safe-guard the produce against theft and pilferage.
e. For speculative prices during the time of scarcity where prices are up.
f. To feed the people throughout the year without any shortage at a certain time.
g. To safeguard against bad times like drought.

MAIN STORAGE PROBLEMS

a. High crop moisture contents
b. Infestation by moulds
c. High storage temperatures
d. High incidences of pest attacks

IMPORTANCE OF CROP STORAGE

a. To save seeds required for planting
b. To provide food between harvesting seasons.
c. To provide farm animals with food even during periods of pasture scarcity.
d. To provide safekeeping of harvested produce for consumption all the year round.

e. To reduce and avoid heavy losses which may otherwise occur in the field.

WAYS OF STORING FOOD TO ENSURE FOOD SECURITY

a. Traditional granaries; in some communities they use pots, and in others a structural design constructed by timber while others roofed by corrugated iron sheets.
b. Modern granaries which handle large quantities of grains like silos
   Requirements of Good Storage Structures
   1. Vermin proof
   2. Well ventilated
   3. Rain-proof
   4. Easy to load and off-load
   5. Easy to clean
   6. Damp-proof
c. Sacks that are free from damp, insect attack and rodent
   Advantages of sacks
   1. Can be isolated and labeled to contain different grain products
   2. Bags are easily moved.
d. Silos. A silo is an air-tight storage facility that allows loading and off-loading grain.

MIXED CROPPING AND MIXED FARMING

Mixed cropping is the growing of two or more crops in the same field but in specific sections of the farm at the same time.

Mixed farming is the growing of crops and keeping of livestock on the same piece of land at the same time.

How mixed cropping and mixed farming can support the growing population.

a. Provide well balanced diet thereby helping in reducing malnutrition.
b. Improving standard of living after sales
c. Reduction of poverty through the earning of income through-out the year.
d. There is insurance against total loss in case of rain failure.
e. Improves soil fertility hence high yield meeting the demand of the high population.
f. Soil degradation is minimized due to complete soil cover hence soil fertility maintained.
g. Control spread of pests and diseases thereby reducing the cost of production.
h. Maximum utilization of soil nutrients in both layers (for both tap and fibrous roots).

IMPORTANCE OF MIXED FARMING TO A GROWING POPULATION

a. Both animal and crop products are realized at the same time.
b. Animal and crop products help in avoiding suffering from malnutrition.
c. The growing population gets income throughout the year.
d. Crops get manure from animals helping the growing population in incurring less cost from the fertilizer purchase.

USING SCIENCE AND TECHNOLOGY TO ACHIEVE FOOD SECURITY

1. Plant and livestock breeding – new techniques have been developed to ensure production of high yielding crops and better livestock breeds.
2. Irrigation technology – this has helped to overcome drought as crops can be grown even in the dry season.
3. Fertilizer production technology – the high analysis fertilizers that have been and developed increase crop yields.

4. Stock feed manufacturing – commercial feeds like concentrates, additives and livestock hormones have increased livestock yields.
5. Pesticide development - this has resulted in more effective control of pests and diseases.
6. Herbicides development – development of chemical weed killers has also led to increased crop yields.
7. Mechanization – this has helped farm operations to be completed in time.
8. Crop processing and marketing – this has ensured that food is kept for a long time.
9. Soil conservation and drainage – this has made land more productive as soil erosion is checked.

DROUGH RESISTANT CROPS WHICH ENSURE FOOD SECURITY.

These are crops like cassava, sweet potatoes, yams, millet and sorghum. They are important because:

1. They adapt to drought therefore they can survive even with little moisture.
2. They mature early
3. They are easy to store i.e. they can be left in the field and harvested when need.

AGRICULTURAL DEVELOPMENT AGENCIES AND SERVICES IN MALAWI

A. LAND HUSBANDRY SERVICES

They aim at promoting and the sustainable use of land resources for agricultural production.

The services are provided by:

1. Land Resources and Conservation Unit
2. Agricultural extension staff in all the Agricultural Development Divisions (ADDs)
3. Land Husbandry Training Centre in Zomba.
4. Environmental Education Unit in Lilongwe.

The services include;

a. Guiding and creating awareness among farmers and the general public about the scarcity and vulnerability of land resources in the country.
b. Providing relevant information, knowledge and skills in all aspects of land use and environmental conservation.
c. Encouraging and helping farmers to construct and establish physical and environmental soil conservation structures.

B. IRRIGATION SERVICES

Where rainfall is inadequate, irrigation helps to reduce the risk of crop failure so that enough crops can still be produced to support the population.

THE DEPARTMENT OF IRRIGATION

It emphasizes self-help, small-scale and community ownership of the schemes
It has established ten sprinkler irrigation schemes, 95 treadle pumps, motorized pumps, and boreholes/shallow wells.

c. **FARM SETTLEMENT SERVICES**

It aims at;

a. Promoting special crops such as cotton and tobacco, maize and groundnuts
b. Promote the participation of women in agricultural development.
c. Encourage handicapped people especially the blind to contribute towards agricultural development.
d. Give farmers who have very few landholdings the opportunity to participate in farming.
e. Improve the spreading of improved agricultural practices to neighboring rural communities.

Farm settlement services are provided by the government 's Rainfall Settlement Schemes such as Rivirivi in Karonga, Kabwafu in Mzuzu, Kasama in Karonga .
Farmers in these schemes obtain high yields because of the advice from extension workers, and assistance on other facilities that are available, such as credit.

FARM MECHANIZATION
Farm mechanization helps to complete farm operation in time so that high yields can be realized
.
FARM MECHANIZATION SERVICES by ADD in particular Ox-training Units

a. Training farmers in the selection, care and management of draught animals and the maintenance of implements
b. Training draught animals in ploughing, ridging, and cultivating
c. Introducing and supplying alternative sources, of draught animals, such as donkeys.
d. Improving the availability of both hand –operated and animal-powered machinery for farmers to buy through credit.
e. Testing and releasing small scale machines such as grain dehullers, oil extraction machines and water pumps .

SEED TECHNOLOGY SERVICES by
Serves to provide good quality seed for improved crop varieties to smallholder farmers for increased crop production.
The department of Agriculture Research (DAR) is responsible for testing, certifying, and monitoring the production, processing, storage, and marketing of seed. All these ensure that farmers obtain good quality seed for planting to get high yields.

The certified seeds are provided by Admarc, PTC, Chipiku,

CROP PROTECTION
It aims at minimizing crop losses due to pests, diseases or weeds.
Services include

a. Breeding and releasing resistant crop varieties by the department of Agricultural Research.
b. Plant pest diagnostic and advisory services provided by the Department of Agricultural Research
c. Recommending the use of specific pesticides supplied by ADMARC.

PROVISION OF FARM INPUTS
It aims at encouraging farmers to use recommended inputs (like stock feeds and fertilizers) and to ensure that they are properly used.
The main suppliers or distributors of fertilizers in Malawi are ADMARC, Norsk Hydro, OPTCHEM, and Farmers ' World.
The main manufacturers and suppliers of stock feeds are Rab processors and the Grain and Milling Company.

SOIL TESTING

Soil is tested to determine the correct type of and amount of fertilizers to be applied in a particular soil in order to increase output for the growing population.
The service is provided by Bvumbwe and Chitedze Agricultural Research Stations. Soil samples are collected by agricultural extension workers from farms to laboratories to make good fertilizer recommendations.

AGRICULTURAL CREDIT TO SMALLHOLDER FARMERS

To facilitate credit provision for farmers to boost their capital for improved agricultural production and support the growing population.
The government of Malawi established the Malawi Rural Finance Company (MRFC) to provide credit to:

i. Smallholder farmers who cultivate under customary land tenure and government agricultural schemes.
j. Small estate farmers owning less than 30 hectares.

FARM MANAGEMENT

Aims at ensuring ensuring effective use of available resources, appropriate combination of enterprises and proper farm planning.
Agricultural extension workers advise farmers about farm planning and budgeting in order to increase farm productivity to support the growing population.

FOOD AND NUTRITION

A Food and Nutrition Unit under Ministry of Agriculture aims at:

h. Helping smallholder farmers in ensuring food security through increased and diversified production and decreased post- harvest losses.
i. Monitoring the food and nutrition situation in Extension Planning Areas, Rural Development Projects, Agricultural Development Divisions and national level.

EXTENSION AND TRAINING

Aims at offering technical information, advisory and support services to smallholder farmers to enable them increase production to meet their needs.
Extension Departments in each EPA achieve this by:

a. Providing direction and technical agricultural advice and information to smallholder farmers.
b. Providing training to farmers at Farm Training Centers to change attitudes and improve knowledge and skills.
c. Strengthening links between researchers and farmers.

The Agriculture Communications Branch also provides technical information and advice.

AGRICULTURAL RESEARCH SERVICES

Aims at developing better crop varieties, animals ' breeds and crop and livestock practices to ensure long-term food security and food self-suffiency.
The services include;

- ✓ -carrying out soil fertility tests to establish the nutrient status of the soil and the right typend quantity to ensure long-term food security.

-breeding and releasing new crop varieties and animal breed that are fast growing, resistant to crops and diseases and high yielding.
-testing, certifying and monitoring seed production, processing, storage and marketing.
-enforcing phyto-sanitary measures to control pests and diseases.
-releasing and recommending better equipment and production methods for adoption and use by farmers.
-carrying out periodic and ad hoc diagnostic surveys for plant pests and diseases.
The services are provided by the department of agricultural research services in the ministry of agriculture and Bunda College of Agriculture.

FARM INPUT SERVICES

Aim at making farmers access cheaper and reliable input in order to increase crop and livestock production on the farm. More agro-dealer shops are in rural areas to improve availability of farm input.

Services provided;

- Stock different farm inputs such as fertilizers, seed, pesticides, herbicides and farm equipment such as sprayers, water pumps and ploughs
- Distribute farm input to areas where they are needed. Government also support through ADMARC.

IMPORTANCE OF AGRICULTURAL DEVELOPMENT SERVICES TO THE GROWING POPULATION.

a. The rise of production of food crops and livestock products leading to the surplus food being exported to earn foreign exchange.
b. The regulation of production of certain crops which shall maintain the prices at high levels.
c. The promotion of horticultural production for commercial and self-sufficiency which will reduce the occurrence of food deficiency diseases such as malnutrition.
d. Good roads enable farm produce reach the market quickly especially perishable goods.
e. The giving of credits increase the ability of farmers to realize more food to the population.
f. Helps small scale farmers to get market for their produce due to bulk selling, thus earning more to meet the domestic demand.

GENDER AND AGRICULTURAL DEVELOPMENT

Gender bias is a favouritism or prejudice which results in discrimination of one sex.

CAUSES OF GENDER BIASES IN AGRICULTURAL TECHNOLOGY

a. Gender stereotyping and lack of early socialization to technology. Boys are exposed to technological innovations early in their lives through making or playing with toys like cars unlike girls who are occupied with domestic work or playing with dolls. The socialization prepares boys to deal with technology but hinders girls.
b. Lack of access to technological information.
Malawi culture favours free mobility of males hence exposing them to increasing chances of seeking information on technology. The perception of parents on education in Malawi prepare them to support the education of a boy more than of a girl, putting a boy at an advantage of understanding technology.
c. Lack of female extension workers and role models. Most of agriculture extension experts are males resulting in only men who benefit from agricultural extension programmes as tradition forbids male-female contacts. More over women have no role models to look up to for inspiration in the use of improved agricultural technology.
d. Lack of access to capital. Males as head of household role, assume control of capital even of wife, making males buy technologies and equipment most useful to them on the farm.
e. Discriminatory attitudes and gender stereotypes. Most money lenders are more comfortable transacting business with male farmers against female who are unable to acquire and use improved technology. It is generally regarded as a taboo to allow women operate high technology machinery and programme such as tractor and artificial insemination and castration.
f. Lack of confidence. Women generally look less confident with technological items due to lack of socialization since early childhood. They just need an exposure to develop confidence.

IMPLICATIONS OF GENDER BIASED APPLICATION OF AGRICULTURAL TECHNOLOGY

a. Low agricultural production as women are deprived to access high agricultural inputs hence fail to achieve high food and cash crop production.
b. Food insecurity. Reduction in agricultural production results in families and the country have inadequate food to take them through the year.
c. Malnutrition. As household and the country is food insecure, intake of food nutrients is low, resulting in families suffer from a wide range of nutritional disorders, which is likely to reduce their economic output.
d. Poverty. Household that are food insecure usually have poor standards of living due to malnutrition and the constant struggle to obtain food. They even fail to educate their children and low household poverty.
e. Slow economic growth and Development. The importation of food stuffs to address food shortage and drains the foreign exchange reserves which in turn affect other sectors of the economy. The malnourished people usually are unable to work in the field or formal employment resulting in reduced economic output.

SOIL DEGRADATION

- Soil degradation is the loss in the value and quality of the soil that make it unable to support plant growth and development. This is because soil that is degraded does not have the right type and amount of nutrient for plant uptake. Additionally, such soil has a poor structure and cannot hold enough water for plant uptake.
- It is mainly caused by soil erosion and loss of soil fertility.

FORMS OF SOIL DEGRADATION

(a) Water erosion
- Running off water carries away top soil making soils infertile. Forms of water erosion are splash erosion, rill erosion, gully erosion and sheet erosion.

(b) Wind erosion.
- Strong winds during the dry season can cause much damage to the soil.

(c) Physical erosion.
- This takes place when the structure of the soil is destroyed by rain or machines.
- The broken particles are then eroded through wind or rain water. If the soil structure is destroyed by rain, the soil particles may not be carried away. Instead the soil becomes puddle and this known as puddle erosion.

(d) Chemical degradation.
- This is caused due to excessive use of fertilizers and pesticides.
- Some fertilizers may cause the soil to be too acidic and therefore toxic to some crops.

(e) Biological degradation.
- This is a type of degradation that is caused by living things particularly animals.
- Animals, people and some microbes are some of the biological agents that bring about soil degradation.
- Animals make tracks as they go down a stream or river to eat and drink. Soil that is trampled by people or animals is broken down and easily eroded through wind or water.
- Earthworms and termites destroy the soil structure making it susceptible to erosion.

(f) Excess salts.
- Excess salts are due to poor drainage, low rainfall, fertilizers and irrigating crops with poor quality water.
- Excess salts increase soil alkalinity, thereby increasing soil pH. This makes the soil toxic for some crops.

(g) Loss of soil fertility.
- This occurs due to removing of top soil through wind and water erosion and continuous cropping by farmers.

CAUSES OF SOIL DEGRADATION

(i) Bad farming practices which include:
   a. Cultivating steep slopes and river/stream banks.
   b. Constructing ridges across the slope.
   c. Using heavy machinery which destroys soil structure.
   d. Continuous cropping which exhausts the soil and makes it prone to soil erosion.
   e. Cultivating the soil when it is too wet or dry which damages soil structure.

(ii) Deforestation due to the excessive cutting down of trees for firewood, charcoal, cultivation e.t.c.

(iii) Uncontrolled fires when clearing the bush.

(iv) Overgrazing due to overstocking.

(v) High human population growth.

Assignment: Explain how these factors cause soil degradation.

WAYS OF CONTROLLING SOIL DEGRADATION
- Soil degradation can be controlled by using biological and physical soil conservation measures.

BIOLOGICAL SOIL CONSERVATION MEASURES.
- Biological soil conservation measures help to reduce damage caused by rainfall. The best method is to ensure that vegetative soil cover is maintained. Examples of biological soil conservation measures are:
  a. Maintaining soil cover by planting trees and grasses. Soil cover is important because:
     (i) It protects the soil from water and wind erosion.
     (ii) It reduces the force at which raindrops hit the soil.
     (iii) It reduces the speed of water runoff.
  b. Planting close growing crops such as groundnuts and sweet potatoes.
  c. Practicing strip cropping to help reduce runoff.
  d. Afforestation (planting large numbers of trees on a bare ground.
  e. Practicing crop rotation.
  f. Adding farmyard manure to the soil.
  g. Mulching.
  h. Controlling bushfires.
  i. Preventing overgrazing.
  j. Conserving grazing areas by fencing and practicing rotational grazing.
  k. Practicing family planning to control human population and hence reduce the pressure on exerted on land and soil resources.

PHYSICAL CONSERVATION MEASURES.
- Physical conservation measures aim at reducing the speed of runoff and allowing the water soak into soil.
- Physical conservation measures include:
  (i) Constructing storm water drains. These divert water from upland into a natural water way or a specially constructed artificial ware way.
  (ii) Constructing tie or box ridges. These help to hold water in furrows, allowing the water to sink into the soil.
  (iii) Constructing contour bunds. These are ridges across the slop following the contour which reduces the speed of running water.

EFFECTS OF SOIL DEGRADATION

(i) Loss of fertile top soil and eventually reduced crop yields.
(ii) Reduced infiltration and increased runoff.
(iii) Silting up of water reservoirs e.g. dams, rivers, lakes due to sedimentation.
(iv) Pollution of water resources.
(v) Rivers drying up and water becoming scarce.
(vi) Low ground water table due to runoff.
(vii) Increased incidence of flooding.
(viii) Loss of arable land due to gullies that are formed.
(ix) Loss of grazing land.

CROP IMPROVEMENT

- Means increasing the productivity of crop plant by developing better cultivars (cultivated varieties), which posses superior characteristics.
- The yield and physical appearance (phenotype) of a crop depends on the environment and the inherited characteristics (genotype) of the seed used.

AIMS AND OBJECTIVES OF CROP IMPROVEMENT

The two main aims of crop improvement are:

(i) To increase the average crop yield (yield quantity)
(ii) To improve the quality of the produce (yield quality)

OBJECTIVES THAT RELATE TO INCREASING YIELD QUANTITY

(i) To increase the biomass (the capacity to produce and retain adequate quantity of dry matter or vegetable material. Obtained through increased growth rate, greater plant vigour, or faster recovery after cutting or grazing.
(ii) To improve partition (the capacity to divert biomass to the desired harvestable portion of the plant) e.g. the root, stems, fruits, and seeds.
(iii) To increase resistance to pests and diseases.
(iv) To improve seasonal adaptation-low altitude areas of Malawi have a short growing season than high altitudes.
(v) To increase tolerance to adverse environment conditions. Crops have been bred to withstand drought, hail winds, colds, heat, water lodging and low soil fertility.

AIMS THAT RELATE TO INCREASING YIELD QUALITY.

(i) To achieve uniformity-in terms of growth rate, maturity time, fruit size, shape and colour. This is important because:-
   a. It facilitates mechanization of farm operations e.g. harvesting.
   b. It maximizes the amount of produce (seeds, fruits, tubers) that can be harvested at a time.
   c. It reduces the need for grading the produce.
(ii) To increase the nutritive value crop products so that crops have high protein and vitamin content.
(iii) To promote dwarfness in crops-in fruits-this makes harvesting quicker, cheaper and more through, reduces plant lodging in rice.
(iv) To improve processing qualities of crop products e.g. high oil content in groundnuts, high fibre (lint) strength, luster, and length in cotton or high sugar content in sugar cane.
(v) To increase the market value of crop products by developing products of better colour, texture and taste) palatability) as demanded by the consumer e.g. MH18 and MH17 for better poundability, taste and storage qualities.

METHODS OF CROP IMPROVEMENT

1. INTRODUCTION

- The importation of crop varieties of superior characteristics to serve as foundation stocks for breeding or propagation, usually after quarantine and testing e.g. Ukiriguru Composite A (UCA) maize from Tanzania, Blue Bonnet rice from USA, and Chitedze Groundnut 7 (CG7 or ICGMS from SADCC/ICRISAT.

2. SELECTION

- Choosing of superior plants that have certain desirable characteristics for breeding or propagation.

(a) Mass selection

- Choosing a large number of plants showing desirable characteristics for seed. Imported variety is grown and the law of 'survival of the fittest' (natural selection) is allowed to operate. Those plants not favoured in the environment die off.

(b) Single plant selection.

- Choosing individual plant for breeding. In any population some individuals do better than others in certain aspects.

3. HYBRIDIZATION

- This is the process of cross pollinating two crop varieties with different characteristics, in order to produce a new variety that combines the good qualities of the two parent crops. The steps involved in hybridization are:

(a) Choosing parents.

This involves choosing of parent varieties with superior characteristics for crossing. For example;

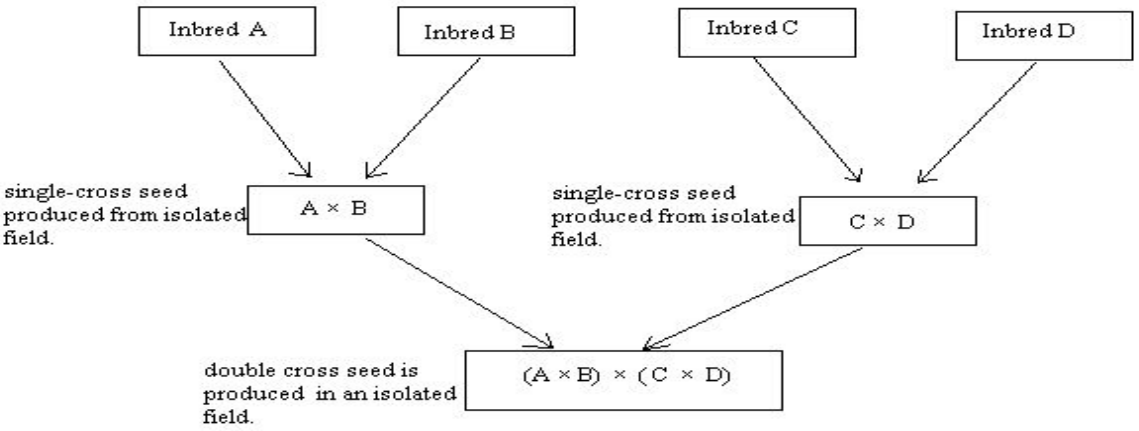
(i) A plant is high yielding but susceptible to diseases to be crossed with a low yielding crop that is disease resistant.
(ii) A high yielder that is tall growing (lodges easily) to be crossed with a low yielding dwarf.
(iii) A late maturing high yielder to be crossed with an early maturing low yielder.

(b) Self pollinating the parent lines.

- The chosen parents are self-pollinated (mated with close relatives) for several 5-6 generations. This is called **inbreeding.** It is done in order to produce pure lines (serfs).
- Inbreeding results in a reduction of plant vigour. This is known as **inbreeding depression.**

(c) Crossing the pure lines.

- Pollen from one inbred (pure line) is collected and transferred manually to the stigma of the flower of the other inbred.
- Cross-breeding results in increased plant vigour called **hybrid vigour** or **heterosis.**
- For crossing of the chosen pure lines to be successful, accidental self pollination is prevented by removing or killing the anthers (male parts of the flower) before maturity. This is called **emasculation.** Pollination by any other foreign pollen is prevented by covering the male part of the flower with a plastic bag.
- The number of inbreds used for crossing and the way they are used determines the type of hybrid produced. The first cross between two inbreds produces single-cross hybrids like MH12 and MH16.
- Crossing two single-cross hybrids produce double cross hybrids. See figure below.



PASTURES

- Pasture is grassland used for grazing or grass and other herbaceous plants used as feed by grazing livestock. Pasture are grasses and legumes found naturally growing or cultivated on a piece of land for feeding animals

IMPORTANCE OF PASTURE

a. Pasture provides feed to livestock.
b. Pasture improves and maintains soil fertility- rhizobium bacteria which live in nodules on the roots of legumes are able to fix atmospheric nitrogen.
c. Pasture improves soil structure-organic matter promotes soil aggregation.
d. Pasture helps in conserving water by encouraging infiltration of water.
e. Pasture controls soil erosion by:
    - Leaves cover the soil and protect it from splash erosion.
    - The fibrous roots bind the soil reducing soil erosion.
f. Pasture controls pests and diseases-some pastures are resistant and break the cycles of pests and diseases e.g. love grass and Katambora Rhodes grass control eelworms (nematodes)
g. To utilize non-arable land for pasture whilst using arable land for

TYPES OF PASTURES

(a) Natural pastures.

- This is uncultivated grassland (dry land or dambo) in which indigenous species are dominant.
- Continuous (communal) grazing is commonly seen in these pastures.
- It is composed of thatching grass, cat ’s tail grass and rapoko.

(b) Cultivated pasture./exotic pasture /pasture ley

- This is planted pasture in which exotic legumes and grass species are dominant. Examples of grasses include Rhodes grass, napier grass, guinea grass and leguminous like stylo, laucaena, centrosema, macrotyloma, neonotonia
- Cultivated pasture can be classified into permanent and temporary pastures.

(i) Permanent pastures.

- Cultivated pasture that contains at least one introduced (improved) grass or legume and is managed for 10-15 years.
- Common species are star grass, bushman, mine panic grass, buffel grass and torpedo grass.

(ii) Temporary pastures.

- These are leys usually lasting 3-5 years. Species include Rhodes grass, guinea grass, love grass, Napier grass and setaria.
- They may be pure stand (grasses only or legumes only) or mixed stand.

Pure stand pasture - grows one type of pasture only either grasses or leguminous

Advantages

a. Easier to control weeds using herbicides
b. Less competition for nutrients, space, light
c. Easier to collect seeds.

Disadvantages

a. Lower yields per unit area
b. More cases of bloat in animals if crops are leguminious only
c. Feed is not palatable if fed alone
d. No control of pest and diseases
e. If pests and diseases attack there is a total loss

Mixed stand pasture - establishment of leguminous crops and grass crops in the same field.

Advantages

a. Higher nutrient value
b. Improve soil fertility
c. Higher yield per unit area
d. Less prone to bloat
e. Guaranteed yield in case of failure of one crop
f. More palatable to livestock
g. Maximum soil exploitation

Disadvantages

a. Difficult to control weeds using chemicals
b. Undesirable competition for nutrients, light and space
c. Difficult to collect seeds.

BENEFITS OF CULTIVATED PASTURES OVER NATURAL PASTURES

(i) Improved pastures tend to give high dry matter yield.
(ii) Higher protein content.
(iii) High digestibility-retain their juvenile stage much longer than natural pastures.

ADVANTAGES OF GRASS-LEGUME MIXTURES.

(i) The combined yield from grass and legume pasture is higher than in a pure stand.
(ii) The nitrates fixed by the legumes are used by the grass to increase the grass yield.
(iii) The legumes have a higher protein content which increases the nutrient content of the feed.
(iv) Legumes have higher digestibility even when mature.
(v) Legumes retain high nutritive value even when mature, providing the much needed protein in the dry season.

SOWING METHODS

A. BROADCASTING.

- Seeds are spread on the soil surface by hand or a fertilizer spreader and are then raked into the soil.

Advantages

(i) Easiest way of sowing tiny seeds i.e. less labour.
(ii) Time is saved-quickest way of sowing.

Disadvantages

(i) Some seeds can be picked away by pests or washed away by rainwater.
(ii) Some seeds may be buried too deep and fail to germinate.
(iii) There may be too many seeds in some places which results in competition.
(iv) It requires a lot of seeds, making it expensive.
(v) Difficult to weed and apply fertilizers.

2. DRILLING.

- Pasture is sown in trenches (drills) made by sticks, hoes or machinery and covered by soil e.g. planet junior 300A seed drill.

Advantages

(i) More efficient since seeds can be placed at the desired depth.
(ii) Fertilizers can be applied more efficiently.

Disadvantages.

(i) Time consuming if done manually.
(ii) Expensive if done mechanically.

3. OVERSOWING (SOD SEEDING)

- Pasture seed is sown into an already existing pasture.
- The existing pasture is reduced by burning or heavy grazing.

Advantages

(i) It improves the composition of the existing pasture through the introduction of desirable species.
(ii) Increases dry matter yield.
(iii) Increases the quality of natural pastures (protein content)
(iv) Maintains soil moisture content.

Disadvantage(s)

(i) The introduced pasture may face competition.
(ii) Higher rodent and insect population.
(iii) Requires high management skills.

4. UNDERSOWING (UNDERPLANTING)

- Sowing of pasture seed under a growing arable crop (nurse crop) such as maize. The nurse crop is allowed to establish first and plant the pasture after weeding the nurse crop.

Advantages

(i) Pasture becomes established a year earlier.
(ii) The farmer harvests an extra crop of maize from the plot.
(iii) It eliminates the cost of land preparation, weeding if done for separate fields.
(iv) The young pasture is protected by the established arable crop from sun or scorch or strong winds.
(v) Higher total (combined) yield from the plot.

Disadvantages.

(i) The yield of each crop is less than in pure stands.
(ii) Competition for nutrients and light etc.

VEGETATIVE PLANTING (VEGETATIVE PROPAGATION)

- Pasture is established using stem cuttings (setts) or root cuttings (splits)
- From splits-bushman panic, star grass and torpedo.
- From setts-Napier grass.
- Stem or rooted cuttings-lotononis variety.
- Stolons-Silver leaf.

Advantages

(i) Plants mature earlier and start producing fruits earlier than in sexual propagation.
(ii) It reduces the problem of dormancy-no need for seed treatment such as scarification.
(iii) It ensures genetic uniformity in crops-pure lines.
(iv) Only way of propagating crops whose seeds are not viable such as bananas.
(v) Vegetative organs are hardier than seedlings.

(vi) Vegetative organs have sufficient food reserves.
(vii) They are readily available to the farmer from the previous crop.

Disadvantages

(i) The risk of transferring diseases to new plants is very high.
(ii) It is more difficult to introduce variation into the crop.
(iii) Vegetative planting materials tend to be bulky.
(iv) It requires knowledge and skills.

PASTURE ESTABLISHMENT PROCEDURE.

- Successful pasture establishment involves carrying out the following activities:
  (i) Choose the right time for sowing.
  (ii) Prepare the land.
  (iii) Select good quality seed.
  (iv) Select the appropriate type of pasture grasses and legumes.
  (v) Select the right amount of seed per hectare.
  (vi) Process the seeds for successful germination.
  (vii) Select an effective sowing method.
  (viii) Apply fertilizer.

TIME FOR SOWING

- Plant early in the rainy season not later than the end of January.
- Land preparation involves clearing the land, ploughing, and breaking large clods.

SELECTING PASTURE SEED.

- Seed quality is expressed as pure line seed content (PLSC)

$$\text{PLSC} = \frac{\text{Purity\%} \times \text{Germination \%}}{100}$$

Certified seeds have:-

- High germination percentage
- Free from trash, weed seeds and diseases.
- Pure-not mixed with other pasture seeds.

SELECTING APROPRIATE PASTURE GRASSES AND LEGUMES (CRITERIA TO USE)

(i) Adaptability to the environment.
(ii) High overall dry matter production per unit area.
(iii) High feeding value-high crude protein content.
(iv) Proposed duration of the pasture (temporary or permanent)
(v) Compatibility with desired species - Climbing legumes (siratro and silver leaf) are selected for growing with taller grasses. Shorter legumes (stylo and lotononis) with shorter grasses.
(vi) Proposed method of utilization of the pasture. Whether pasture will be used for grazing, hay, silage or cut and carry. Leucaena is suitable for cut and carry than lotononis and style.
(vii) Continued digestibility of the grasses and legumes.
(viii) Resistance to local pests and diseases.
(ix) Adaptability to the ecology of the area.
(x) Percentage of germination.
(xi) Percentage seed purity.
(xii) High tolerance to water logged conditions.

(xiii) Role of the pasture in the rotation-such as nitrogen fixation and control of parasites and diseases.

It is advised to use seeds of high Pure Line Seed Content (PLSC). It expresses the seed quality, the higher the figure the higher the seed quality.

SEED RATE

- This refers to the amount of seed required per hectare expressed in kilograms per hectare.

$$\text{Seed rate} = \frac{\text{Expected plant population}}{\text{Hectare}} \div \text{Seed size} \div \text{Purity \%} \div \text{Germination \%}$$

Example

Workout the seed rate for buffel grass where

Seed rate = 300,000 seeds/Kg

Purity % = 80%

Germination % = 30%

Expected plant population = 900,000 plants.

$$\text{Seed rate} = \frac{900{,}000 \text{ seeds}}{1\text{ha}} \div \frac{300{,}000 \text{seeds}}{1\text{kg}} \div \frac{80}{100} \div \frac{30}{100}$$

$$= \frac{900{,}000 \text{ seeds}}{1\text{ha}} \times \frac{1\text{kg}}{300{,}000 \text{ seeds}} \times \frac{100}{80} \times \frac{100}{30}$$

$$= 25\text{kg/ha}$$

$$= \frac{25}{2} = 12.5 \text{ kg/ha}$$

Plant population per hectare can be found by;-

Plant population = seed rate × seed rate × seed size × purity % × germination %

FACTORS AFFECTING SEED RATE.

(i) Purity of the seed

- If the seed is not mixed with a lot of trash (weed seeds and other crops) more seeds will be required for planting in order to achieve the desired population.

(ii) Germination percentage.

1. The higher the germination percentage, the lower will be the seed rate required to achieve the desired plant population.

(iii) Seed size.

2. Small-seeded species are sown at the lower seed rate since there are more seeds per kilogram. For example, lotononis can be sown at 0.5-1kg/ha while large-seeded legumes like leucaena are sown at 5-30kg/ha.

(iv) Pure stand or mixed stand

3. Where grass/legumes mixtures are to be established, the seed rate for each is reduced in order to reduce interplant competition.

(v) Soil tilth

4. If the seed bed is well prepared with fine tilth the seed rate can be reduced since a larger number of seeds can germinate.

(vi) Growth habit of the species

5. Grass or legumes with larger vegetative growth require lower seed rates in order to reduce mutual shading.

(vii) Method of sowing.

6. Some methods of sowing require more seed because they result in reduced germination or survival of seeds or seedlings e.g. broadcasting require higher seed rates than drilling.

SEED TREATMENT

- Seed treatment is the processing / handling of the planting materials (seeds) in order to improve germination and promote successful establishment.

METHODS OF SEED TREATMENT.

1. HULLING /SHELLING

- The remove of the pod from around the seed. Pods delay germination e.g. cook, stylo and silver leaf.

Advantages:

(i) Increases the rate of seed germination.
(ii) It makes pelleting of the seed easier.
(iii) It ensures a more even distribution of broadcast seeds.

2. SCARIFICATION

- The process in which the hard testa (seed coat) of some legumes are softened in order to speed up germination.
- Methods of scarification are:

(i) Physical or mechanical- by scratching or chipping of the testa using machines.
(ii) Hot water treatment-immerse in boiling water for 12 minutes.
(iii) Dry heat treatment- put seeds in an oven set at 80 ^{o}C for 8 minutes.
(iv) Chemical treatment-dip seeds in concentrated hydrochloric acid and sulphuric acid for 2 minutes and wash under tap water to stop the reaction.
(v) Biological-animals contain HCl in their stomachs which weaken the seed coats which germinate when passed out as dung.
(vi) Burning

3. INNOCULATION

- The process of mixing a legume seed with the correct type of rhizobium bacteria before sowing to ensure successful nodulation and nitrogen fixation. It encourages nodule formation hence boosting nitrogen fixation.

4. PELLETING

- The practice of sticking a thin layer of material such as lime, gypsum or rock phosphate around each seed.
- It improves legume pasture establishment by correcting the soil pH or soil nutrient deficiencies.
- Pelleting of inoculated seeds with gypsum is not recommended since it increases the acidity which kills rhizobium.

5. **CLEANING** . The removal of chaff and off-type seeds to improve the seed purity.

PASTURE MANAGEMENT.

- This involves caring for established pastures to ensure increased and sustainable productivity.
- It involves applying fertilizer, weeding, controlling pests and diseases and utilizing the pasture properly.

FERTILIZER APPLICATION

- Apply 23:21:0 +4S at the beginning of the rainy season.
- Apply CAN fertilizer after each cut or grazing.
- Super Phosphate to legumes at the start of each rainy season to promote nodulation and nitrogen.

- Potassium to cut and carry pastures to replace soil potash.

CONTROLLING WEEDS

- Weeds compete with pastures for light, water and soil and nutrients.
- Some weeds are poisonous to livestock e.g. young rapoko.
- Weeds in broadcasted pastures can be controlled by hand weeding, selective hoeing, slashing or mowing. In forage crops in rows e.g. pearl millet by machines.
- In pure grass leys, broad leaved weeds can be controlled by spraying herbicides such as 2,4D at the rate of 2kg in 90 litres of water per ha.

CONTROLLING PESTS AND DISEASES.

- Army worms and elegant grasshoppers can be controlled by spraying Carbaryl.
- Termites by Diedrin and aphids by Malathion.
- Diseases by rogueing off infected plants.
- Rogueing is the selective removal or uprooting diseased plants.

GRAZING MANAGEMENT. (Grazing on a pasture is termed as defoliation)

- This aims at obtaining high levels of livestock production per unit area without causing sward degeneration.
- Grazing management can be achieved by:
    a. Controlling stocking rates (beasts per hectare) – stocking rate is the number of number of animals of a specified type grazing on a unit area of pasture at any time.
        - Under stocking results in a wastage of herbage (fodder) and selective grazing of delicious species.
        - Overstocking (high stocking rates) leads to overgrazing, soil erosion, bush encroachment and low livestock production.
    b. Matching grazing to pasture carrying capacity (the maximum number of animals of a specified type, which can be fed on grazing area of a pasture throughout the whole year without decreasing productivity of the pasture or livestock). This depends on the yield potential and quality of the pasture.
    c. Providing sufficient grazing intervals (rest periods)
- A grazing interval is the length of time between two successive grazing periods or cuts in a paddock.
- Pasture should be over mature, fibrous and indigestible.
- In rotational grazing, strip grazing and cut and cut and carry system allow rest periods.

EFFECTS OF EARLY DEFOLIATION (LESS THAN 4 WEEKS)

a. It has low dry matter yield hence low in nutrients
b. It has low crude protein content
c. It has high dry matter digestibility but low digestible nutrients
d. High moisture content
e. Early defoliation leads to gradual weakening of the stand and reduction in the life of the stand.

EFFECTS OF LATE DEFOLIATION (MORE THAN 10 WEEKS)

a. High cellulose content
b. High dry matter content
c. High lignin content
d. Low crude protein content
e. Low leaf: stem ration hence reduced palatability
f. Low digestibility

LIMITATION OF OVERGRAZING

a. Gradual increase of weeds
b. Pasture crops are gradually weakened
c. General land degradation as soil erosion sets in due to trampling

LIMITATIONS OF UNDERGRAZING

a. Gradual increase of weeds
b. Leads to wastage of forage as animals foul graze
c. Forage gets too woody and unpalatable
d. Decline in regrowth of pasture
e. Low growing pasture plants are smothered due to shading effects

GRAZING SYSTEMS.

1. ROTATIONAL GRAZING

- Animals move at regular intervals around a series of paddocks so that each paddock has a rest period for recovery.
- A paddock is an enclosed (fenced) area of pasture that provides herbage to livestock for a short period (2 to 4 weeks)
- A paddock can be grazed for 2 weeks and rested for 2 weeks.

Advantages

(i) Pasture is allowed to rest to recover.
(ii) Very palatable species are not grazed out.
(iii) Controls soil erosion since overgrazing is avoided.
(iv) Controls pests and diseases by breaking their life cycles.
(v) Dung and urine are evenly distributed for increased fertility and production.

Disadvantage

(i) Requires a lot of capital for fencing and watering.

MODIFICATIONS ON ROTATIONAL GRAZING.

(a) Strip grazing

- Animals are confined to a very small fenced strip of pasture for a day or two and forced to eat all the herbage present before being moved to another fresh area (strip). An electric fence may be used.

Advantages

(i) Allow pasture to be used more completely.
(ii) High quality pasture is available (fresh, digestible and high crude protein content)

Disadvantage(s)

(i) Expensive to fence small strips.

(b) Fold system

- Tent is used to move animals from one section to another.

© **Herding.** A herdsperson controls the grazing by moving animals to another place after the grass level drops.

(d) Tethering. Involves trying an animal to a post with a rope for it to feed within a restricted area and is moved to another area when the grass level is reduced. The limitation of the method is that it causes wastage through trampling and defecation by the animal.

2. ZERO GRAZING (CUT AND CARRY OR STALL-FEEDING)

- Pasture is cut daily (by hand or forage harvesters) and transported to stalls to feed animals.

Advantages

(i) Ensures 100% utilization of pasture.
(ii) It avoids trampling of grass and soil by livestock.
(iii) It prevents animals from feeding selectively.
(iv) Disease control-the risk of animals contracting infectious diseases is low
(v) It eliminates the risk of overgrazing
(vi) Avoids excessive trekking (walking) in search of feed and water.
(vii) Requires less capital due to no fencing
(viii) Requires less space requirement due to high stocking rate
(ix) Quick accumulation of manure

Disadvantage

(i) High labour- intensive to harvest the pasture and give it to livestock in pens.
(ii) High initial capital required to establish stalls
(iii) High level management skills required (mix maintenance and production ration)
(iv) Fast spread of diseases in the stall

3. CONTINUOUS GRAZING

- Animals are placed on a pasture for prolonged period without allowing the pasture to rest.
- Grazing areas are communally owned.

Advantages

(i) Cheap since it does not require fencing.
(ii) Requires less labour to move animals around.

Disadvantages

(i) Build up of parasites on the pasture.
(ii) Does not give the pasture time to recover.
(iii) Leads to overgrazing due to overstocking-no ideal stocking rate.

4. DIFFERED GRAZING

- Pasture is grazed during the dry season only allowed to mature and left standing in the field in the rainy season e.g. dambos.

Advantages

(i) Ensures availability of some feed during the dry season.
(ii) Cheap method of preserving feed.

Disadvantage(s)

(i) Allows herbage to become mature, fibrous, and less digestible, less nutritious.

BURNING PASTURE.

- Controlled burning is a common practice on natural pastures.

Advantages

(i) Removes the dry inedible herbage encouraging fresh pasture to grow.
(ii) Prevents woody shrubs from inhabiting pastureland
(iii) Reduce competition for growth between selectively grazed palatable species and ungrazed unpalatable species.
(iv) Controls pests, parasites and diseases by burning off the pests, their life cycle and infected pastures.
(v) Reduces weed plants not eaten by animals.

Disadvantages

(i) Burning destroys the legume component.
(ii) Reduces sward vigour if rootstock is burnt off.
(iii) Death of some pasture
(iv) Encourages soil erosion

PASTURE CONSERVATION

- The practice of preserving the abundant herbage in the wet seasons so that it can be used in the dry season. Pasture can be preserved in form of hay, silage and foggage.

REASONS FOR PASTURE CONSERVATION

h. For better and full utilization of available land, as regrowth is stimulated.
i. Ensures availability of livestock feed throughout the year.
j. Source of income as it may be sold to generate income to the farmer.

1. HAY

- Hay is herbage that is cut and cured (preserved) by partially drying to 15-20%, it for letter use as livestock feed.
- Rhodes grass, silver leaf and siratro are suitable for hay.
- Napier grass is too course and becomes unpalatable when dry. Stylo is also unsuitable because the leaves tend to shutter as they dry.

USEFULNESS OF HAY TO THE FARMER

(i) It can be kept for relatively long periods without loss in nutritive value if properly stored.
(ii) It provides the cheapest source of animal feed.
(iii) It supplies most of the energy, vitamins, minerals and proteins to livestock in the dry season.
(iv) It supplies most of the fibre which is required as bulk (roughage) to satisfy animals ' hunger and to facilitate peristalsis (movement of feed along the digestive tract.
(v) It can be sold for cash just like any other crop.

GOOD QUALITY HAY

(i) Clean and dry at 20 moisture content.
(ii) Pleasant smell and test.
(iii) Free from foreign matter.
(iv) Has a greenish tinge.
(v) A pliable texture.

HAY MAKING PROCESS

(i) Cutting

- Cut just before the plant flower to obtain the most nutritious and palatable product.

(ii) Drying

- Partially sun-dried for about 3 days to a moisture content about 15-20%. Over drying decreases the carotene content (vitamin A) and lowers its quality.

(iii) Stacking

- Grass is baled (compressed) or stacked loosely piled in a leak proof shed

FACTORS AFFECTING HAY QUALITY

(i) Pasture species with more legumes gives higher crude protein.
(ii) Stage of growth (age) of cutting as herbage before flowering has a lot of nutrients. Delay in harvesting leads to lower nutrient content as it is used in seed setting.
(iii) Degree of turning and drying – high moisture content develops moulds and loses taste.
(iv) Leafiness/stem ratio of herbage as the higher the ratio the higher the quality.
(v) Presence of foreign materials (weeds, poisonous plants) lowers quality.
(vi) Weather at harvesting and drying – rainy weather or showers lengthen the period needed for herbage to dry and cause loss of nutrients from the hay.
(vii) Length of drying period, as prolonged exposure leads to bleaching of nutrients.
(viii) Degree of damage as it may lead to leaf breakage, fermentation or bleaching.

(ix) Storage of the hay; wet or leaking storage facilities lower nutritive value of the hay.

2. SILAGE

- This is green forage that is preserved by anaerobical fermentation. The process of silage making is called ensiling and place is called a silo.

SILAGE MAKING PROCESS

a. Prepare the silo which depends on the amount of forage material available.
b. Cutting-grasses just before flowering and legumes at podding stage.
c. Partial drying- about 65-75% moisture content.
d. Chopping-forage is cut into shorter lengths to aid compression/compaction.
e. Stacking-forage is placed in a pit silo or tower silo. Stacking is done quickly and compactly as possible to eliminate air (oxygen). Each layer is mixed with a carbohydrate concentrate e.g. molasses to provide energy for the bacteria in the silo and additives to improve quality.
f. Compressing-pushing out oxygen. The silo is then sealed by soil or plastic sheeting to make it airtight.
g. Fermentation-by anaerobic bacteria. Lactic acid produced gives the silage a pleasant smell, lowers pH in the silo to about 4. The heat and the low pH in the silo kill anaerobic bacteria and prevent further multiplication hence preserving the silage.
h. Cover the silo with a thick layer of soil to form a concave appearance.
i. Dig a trench around the silo to drain off rainwater.

Effects of too much air in silage making

a. Over heating
b. Decomposition

Advantages of silage

(i) It makes use of a wide variety of forages e.g. Napier, maize, sorghum and stylo.
(ii) It preserves a higher percentage of protein than hay.
(iii) Maintains the succulent (juicy) state of green fresh forage.
(iv) Less vitamin A is lost than in sun cured hay.
(v) Free of weed seeds since they are killed by the heat in the silo.
(vi) Can be kept for long- hence better preserved.
(vii) Less dependent on weather conditions.

Disadvantages

(i) More expensive to make and requires a lot of labour.
(ii) High moisture content reducing the amount of dry matter.
(iii) High level skills needed
(iv) Grass loses original taste
(v) Must be fed as soon as removed from silo
(vi) Bulky to store and handle
(vii) Susceptible to loss of nutrients through seepage and volatilization.

TYPES OF SILO

1. Clamp silo. Constructed above the ground with slanting walls made of timber or stone
2. Trench silo. Rectangular excavation underground.
3. Bunker silo. Made of concrete above the ground level with perpendicular walls for mechanical ensiling.

QUALITIES OF GOOD SILAGE

a. High quality forage cut at proper stage of growth
b. Have ph of 4.2 or below
c. Have 5 to 9 % lactic acid

d. Free from moulds and bad odours like ammonia and butyric acid
e. Green to yellow in colour but not brown or black
f. Have a fine texture but with no slimness

FACTORS AFFECTING SILAGE QUALITY.

(i) Type of plant material used whether either grass or legumes only or a mixture as legumes have higher crude protein hence higher nutritive value.
(ii) Availability of carbohydrate to provide energy for the bacteria.
(iii) Additives added like molasses and grains increase the palatability of the silage.
(iv) Speed of filling the silo as faster filling of silo is best, minimizes loss of nutrients through volatilization.
(v) Fineness or coarseness of chopped materials as the higher the leaf/stem ratio the better palatability.
(vi) Tightness of the air seal, or extent of compaction affects temperature in silo crucial for fermentation.
(vii) Amount of protein broken down during fermentation.
(viii) Water content of the herbage. Higher moisture content lowers the quality(sour)
(ix) Age or stage of maturity of the crop harvested when ensiling. Flowering stage is best as it has lots of nutrients.
(x) pH value of the forage.
(xi) Drainage of the area and shelter against rain water as leaking shelter lowers quality

3. FOGGAGE.

- Foggage is standing hay left ungrazed for use in the dry season.
- Part of the pasture land is not grazed until the end of the rainy season.
- The quality of the herbage depends on the persistence of the pasture species sown i.e. how palatable and digestible they are as a mature plant and the grass/legume ratio of the pasture.

The advantage of foggage

j. to farmer is that it is a cheap method of preserving feed.

The disadvantage

k. it reduces the quality of the feed since it is mature, with more fibre,
l. low digestibility
m. low crude protein content.

FACTORS AFFECTING THE QUALITY OF PASTURE

(i) Pastures species grown as leguminous are rich in crude protein
(ii) The ratio of legumes to grasses in the pasture, as the lower the ratio the higher the digestibility. Feeding legumes alone causes bloat.
(iii) Palatability of the species grown as some younger and legumes are more palatable.
(iv) Digestibility of the species as depends on stage of growth of pasture, younger plants are highly digestible than mature fibrous plants.
(v) Crude protein content of the species as legumes and grasses have varying amount of crude protein.
(vi) Regeneration ability of the species i.e. ability to grow again after cut or grazing.
(vii) Persistence of the species i.e. ability to continue to grow and look fresh, green and juicy, well into the dry season, instead of drying up and becoming fibrous.
(viii) Leafiness of the species grown as at flowering stage pastures provide highest nutritive value.
(ix) Wet-site tolerance –ability to grow successfully in waterlogged areas or dambos.
(x) Drought tolerance of the species grown.
(xi) Resistance to pests and diseases.
(xii) Soil fertility as level of nutrients in the soil determines the mineral composition of pasture.

(xiii) Toxicity level of the species used. Some pasture species have (alkaloidpoisonous substances which inhibit cell division in livestock.
(xiv) Presence of weeds in the pasture.
(xv) Soil fertility and type/ amount of fertilizer applied. Some nutrients make pastures succulent e.g. nitrogen while others help the grass to retain its fresh and juicy state for longer e.g. potassium.
(xvi) Pasture utilization. Grazing management systems which allow the pasture to rest or recover result in better pastures in terms of both quality and quantity.

CROP PROCESSING AND STORAGE

- Processing crops means handling the crops and preparing them for consumption or storage by changing their form (raw material) to a form that consumers can use (finished product)
- Storage means preserving the crop produce for future use.

PROCESSING AND STORAGE OF MAIZE

- This involves:

1. Stripping the maize cob sheath (Dehusking).

- Removing husks

Advantages

(i) Exposes the grain to air and dry.
(ii) Storage pests can readily reach and protect the grain.

Disadvantages of storing Maize cob with Husks.

(i) Husks prevent through drying and trap moisture.
(ii) Husks may contain moisture which encourages moulds.

2. Shelling the grain

- Removal of the grain from the cob.

Advantages

- Speeds up drying.
- Less storage space.

3. Drying the grain

- Sun dried or forced air dehydrators or electric driers to 10-12% moisture content.

Advantages

(i) Prevents growth of moulds.
(ii) To make testa hard strong to resist pest attack.
(iii) Reduces the respiration rate of keeping grain temperature lower.
(iv) Prevents germination of the grain.

4. Cleaning

- This is done by winnowing to remove chaff.

6. Dusting. The grains are treated with appropriate pesticides to protect them against pests.
7. Packing in standardized bags for marketing.

STORAGE FOR MAIZE

(i) Shelled maize in tins, baskets, drums or sacks.
(ii) Unshelled maize in Nkhokwe.

CHARACTERISTICS/CONDITIONS OF GRAIN STORES.

(i) Dry-to prevent moulds.
(ii) Cool-to prevent grain heating and increased respiration rate.
(iii) Clean-to prevent pathogens.
(iv) Airtight-no holes to keep out pathogens and pests.

PROCESSING AND STORING GROUNDNUTS

- Stored in the pod (unshelled) in a Nkhokwe or shelled in sacks.
- Drying and cleaning are essential.

PROCESSING AND STORING SWEET POTATOES.

- This involves:
  - (i) Cleaning-remove all dirt and debris.
  - (ii) Selection, removing those with mechanic bruises or pest damaged.
  - (iii) Drying (Curing)-spread tubers in a cool, dry shaded place (29-30 ^{o}C) at a relative humidity of 85-90% for about 5 days. Moisture is reduced and the skin gets thicker or tougher and wounds are healed.
  - (iv) Piling-a soft bed (layer) of grass or banana leaves at the base (floor and top) can cushion them.
  - (v) Storage-stored in a cool dry dark place. A pit lined with a layer of sticks and covered in dry grass or leaves preferably in a

  Short tubes of bamboo stems, Ventilation holes are inserted into the pile to help in ventilation, heat and moisture loss .

4. PROCESSING AND STORING CASSAVA.

- Cassava is best stored in a processed form in sacks and consumed after cooking or baking.
- Fresh cassava tubers be peeled, sliced and dried in the sun.

Advantages of processing cassava.

(i) Reduces the toxicity of the tubers (removes cyanogenic glucosides).
(ii) Improves their palatability.
(iii) Makes the perishable commodity last long enough.

5. PROCESSING MANGOES FOR STORAGE

- Mangoes are best stored in processed form of chutney or jar of juice.
- Procedures for storing fresh mangoes:
  - (i) Wiping off any latex which has oozed
  - (ii) Select fruits that are in good condition (unbruised)
  - (iii) Cooling fruits quickly to 7-10 ^{o}C.
  - (iv) Disinfecting the fruit to prevent fruit flies.
  - (v) Pressing it through a food mill or hand operated fruit press.

(vi) Lemmon juice is added to taste.
(vii) Juice is frozen or canned for storage.

7. **PROCESSING OF AMARANTHUS (BONONGWE)**

May be harvested when abundant and preserved as dried vegetables or placed in a freezer.

Drying. The leaves are branched and boiled in water to retain colour and flavor.
Then the leaves are put in oven temperatures of 60 degrees for drying.

Freezing. The leaves are branched first before freezing at 21degrees to 18degrees.
Packages for freezing is moisture proof and vapour proof with little air to prevent oxidation during storage. The packages are placed in a freezer.

IMPORTANCE OF CROP STORAGE

a. To save seeds required for planting
b. To provide food between harvesting seasons
c. To provides animals with good food even during periods of pasture scarcity.
d. To provide a safe keeping for harvesting produce for consumption all the year round.
e. To reduce and avoid heavy losses which may occur in the field.

TYPES OF STORES

LIVESTOCK IMPROVEMENT

- This is the attempt to improve the genetic makeup of the livestock and the environment in which they are kept to increase production.
- Production characteristics are passed on to the offspring during fertilization.
- The hereditary materials (genes) are carried by chromosomes. The potential of an animal to produce is largely determined by:
  1. The genes that it inherits from parents.
  2. The environment.
- The farmer can modify and improve the environment through proper housing, feeding and controlling diseases and parasites.

AIMS OF LIVESTOCK IMPROVEMENT

1. To increase production capacity (potential) of the animal in terms increasing yields of milk, meat and eggs.
2. To improve the quality of animal products e.g. butter fat content in milk, size and colour of egg yolk, hardness of egg shells, quality of wool and hardness of work animals such as oxen.
3. To increase disease resistance in animals.
4. To breed animals those are tolerant to adverse climatic conditions.
5. To improve the rate of growth i.e. shorter time to reach maturity.

METHODS OF LIVESTOCK IMPROVEMENT

1. SELECTION

- This means choosing animals with desirable characteristics for breeding. A deliberate decision is made to allow some animals to be parents of the next generation.

AIMS OF SELECTION

h. To change the frequency with which certain genes occur in a population of animals.
i. To increase the value of farm animals and increase productivity.
j. To increase the frequency of desirable genes and decrease the frequency of undesirable genes.

METHODS OF SELECTION

A. INDIVIDUAL OR MASS SELECTION

The selection of individuals based on their performance in terms of outward appearance (phenotype). Examples of phenotype characteristics chosen are both observable such as coat colour, size of body, shape of head, and measurable such as body weight and milk yield.

B. SELECTION BY CONTEMPORARY COMPARISON

The selection of animals based on their individual performance after similarly treated of the same age- group compared within the same environment.

C. SELECTION BY PROGENY TESTING

- Selection of male animals based on the performance of their offspring is called **progeny testing.**
  This is the measurement of the genetic value of the animal on the basis of the production records of its offspring. Progeny testing helps males to transmit the production potential to its female offsprings.

D. SIB- SELECTION

- Selection of female animals for production characteristics such as high egg and milk production is called **sib selection.**
  It is a selection programme based on the phenotype value (superior performance) of the offspring of a particular animal.

FACTORS TO CONSIDER DURING PROGENY TESTING/SIB-SELECTION

i. Test as many sire offsprings as possible (5-10)
ii. Randomize dummies to each sire within age group
iii. Produce as many offsprings per sire as possible (10-15) of either sex
iv. No offspring should be culled till end of test.

- **Artificial selection** is the selection of animals by farmers based on desirable characteristics or good qualities. Continuous artificial selection will help fix desirable characteristics on the animals.
- **Natural selection** is the selection of those animals within a group that are better favoured by the environment than others (survival of the fittest)

Characteristics of livestock to be selected for breeding

1. High rate of egg laying and good size of eggs.
2. Good brooding habit.
3. Good mothering ability (good milker, gives birth to live young animals and is able to suckle the young ones)
4. Faster growth rate and low infant mortality.
5. High fertility – high milk yield and quality.
6. High meat quantity and quality-docile.
7. Resistance to diseases and ability to work.
8. Health and strong looking animals.
9. Efficient in converting pasture to high quality products such as milk, meat (feed conversion efficiency)

2. BREEDING

- This refers to improving livestock through mating i.e. inbreeding or out breeding for the purpose of producing animals with desired traits. The quality of an animal depends on the

genetic characteristics inherited from the parent stock and the prevailing conditions under which the animal is raised.

- Within a cell has nucleus which has chromosomes. Chromosomes carry units of inheritance called genes.
- **Inbreeding** refers to mating closely related animals e.g. mother son and son, father and daughter, brother and sister.
- The advantages of inbreeding are:
  (i) Brings about uniformity in the animals.
  (ii) Fixes desirable genes if it is done for over a period of 10 years pure breeds are produced.
- The disadvantage of inbreeding is that it results in loss of vigour (energy and strength) and performance in the animals, because undesirable characteristics (weakness and defeats are also passed on by parents)
- **Out breeding** refers to mating of animals that are not closely related. The animals can be from same breed (out crossing or line crossing) or different breeds (cross-breeding) e.g. when first cousins mate.
- The advantages of out breeding are:
  (i) It introduces "new blood" in the herd.
  (ii) It brings about hybrid vigour or heterosis.
- Hybrid vigour is superiority in performance much above their parents resulting from cross breeding two unrelated animals e.g. growing faster, producing more milk and eggs. Hybrids exploit the good traits from either of the two parents. This is because a larger number of dominant genes are brought together in the progeny than are found in the parental animals Hybrid vigour is mostly evident when the animals crossed are completely unrelated. For example cross-breeding of a Bos Taurus and Bos indicus animal, results in progeny that have average performance between the parents, with hybrid shown in the first crossing. Dominance is the breeding character that suppresses the other, while recessive is the character suppressed or dominated (masked) by another

3. INTRODUCTION.

- The practice of bringing exotic pure breed animals with desirable characteristics into ones own country.
- These animals e.g. Jersey are from temperate areas so they require better management (feeding, housing and disease and parasite control) if they are to maintain their high production.

ARTIFICIAL INSEMINATION

- Is the artificial introduction of sperms into the reproductive tract of a female animal.
- Semen is collected from the male animal using artificial vagina as the animal tries to mount the female animal. The bull is actually teased.
- The semen is diluted using diluents consisting of egg yolk, milk and glucose. It is stored in nitrogen.
- During insemination, the semen is inserted directly into the uterus.
- The advantages of artificial insemination are:
  1. Very economical, as the cost of buying, transporting and keeping a male animal is eliminated.
  2. The spread of sexually transmitted diseases such as contagious abortion (brucellosis) is reduced.
  3. The sperm can be stored for a long time and used when required even after death of bull.
  4. Semen from one male animal can be used to serve many females (up to 200 cows)
  5. Through keeping records it is easy to track which female has been served.

6. Semen from heavy males can be used to service small female animals which cannot withstand natural mating.
7. Helps in controlling inbreeding in livestock
8. It is easy to plan a breeding program.

The disadvantages of artificial insemination are:

1. It is expensive to set up and maintain an AI program.
2. Timing for AI administration may be a problem since it is difficult to detect heat.
3. The collection and administration of AI requires trained and experienced personnel.
4. Distance may limit communication from AI headquarters top farms. (not feasible in areas which are not easily accessible by A.I. officers.
5. AI does not achieve 100% results. The success rate of conception (cows becoming pregnant) is 80%.
6. If not carefully carried out it may spread sexually transmitted diseases.
7. Poor detection of oestrus and timing of insermination by the farmer may lead to failures in administering A.I.
8. It can be disastrous to the farmers if semen from inferior bulls are accidentally distributed for use.

BEEF PRODUCTION

It is the practice of raising cattle for meat.

Importance of beef production

1. Source of food rich in protein for human consumption, for growth and proper functioning of body.
2. Income through sale of live animals, meat and by products (manure, hides and bones)
3. Source of manure for improving soil fertility from dungs.
4. Source of raw materials such as hides for leather manufacturing and leather products.
5. For social functions such as used as dowry for the bride in marriages.

BREEDS OF BEEF CATTLE

Differences between indigenous and exotic breeds

a. Indigenous are endemic to the local environment as they are well adapted to the local parasites, diseases and weather conditions as compared to the exotic breeds
b. Indigenous breeds grow slowly compared to exotic ones.
c. There is poor performance that is compounded by poor management and scarcity of improved pastures and concentrates at smallholder level.

Breed	Colour	Origin
Malawi Zebu	Mixed-black or white	Indigenous
Afrikander	Black	South Africa
Boran	Mixed-red, white, white gray or brown	Kenya
Charolais	White	France
Hereford	Deep red with white face and legs	United Kingdom
Brahman	White or greyish	India
Simmental	Light red with white patches and white head	

CHARACTERISTICS OF BEEF BREEDS

1. Rectangular or square shaped (blocky) for more beef at slaughter.

2. The body is compact and deep (a lot of flesh good for commercial).
3. They have heavy bodies with a lot of flesh.
4. Good foragers and are efficient in converting pastures to high quality beef.
5. Grow faster and mature quickly.
6. Legs are short but heavy to carry the heavy body of the animal.
7. They breed regularly.
8. High tolerance of pests and diseases.
9. High tolerance of heat and are able to survive long drought periods without losing weight.

MANAGING BEEF CATTLE

FEEDING

A newly born calf is fed on colostraum during the first 4-5 days after parturition.

Importance of colostraum to new born calf

i. it is highly nutritious as is rich in proteins, vitamin A, vitamin D, vitamin E, minerals and fats
ii. it is highly digestible hence suitable to newborns
iii. rich in antibodies which pass immunity from mother to calf
iv. has a laxative effect which clears the first faeces from the digestive system

(i) Extensive system.

- This is a system in which cattle are grazed on a vast communal grazing grassland e.g. ranching like at Dzalanyama in Lilongwe and Kuti in Salima.

Advantages

1. Cheap as no much investment such as fencing, watering points, fire breaks, dip tanks, no demand for labour.
2. Accommodate a large herds of animals according to the carrying capacity
3. It gives some free time for the farmer to perform other farm activities
4. Not labour demanding as it does not require moving animals from one paddock to another or carrying the feeds daily into the stalls.

Disadvantages

1. Leads to overgrazing and land degradation if stocking rates exceed the carrying capacity.
2. Incidences of tick-borne diseases are high hence difficult to control diseases and parasites.
3. Not ideal for speedy fattening of the animals as it takes time to reach slaughter weight due to walking long distances.
4. It may be expensive if due consideration is made to reduce risks such as drought, fire, and tick borne diseases with investments such as paddocks, fencing, and dip tanks.

(ii) Intensive System.

- Beef cattle are confined to either in well thatched, well drained and specious stalls with feeds brought and fed on animals.

Advantages

1. Animals fatten up (gain weight) more quickly as animals save energy (not walking)
2. Ideal for areas where land is scarce with no communal land
3. Helps a farmer to control Diseases and parasites such easier as they are unable to complete their life cycle due to absence of host animals.
4. 100% utilization of feeds especially with zero grazing as animals have no choice, and don ’t trample on the grasses.
5. Grass is given chance to grow –where rotational grazing is practiced.

Disadvantages

- High Capital requirement- Expensive to construct stalls and paddocks.

- Labour intensive in terms of feeding animals in stalls and very burdensome where farmers walk long distances.
- Farmers are restricted to small populations which can be accommodated and fed on the available land and pasture respectively.

Note: Three to four weeks prior to slaughter, the animals even animals from extensive farming given are concentrates in the form of maize meal, madeya, bean meal, and salt to finish them up in an Intensive system is also called "cut and carry" or "zero grazing"

HOUSING STALL-FED ANIMALS

- The khola should be well ventilated and roomy. Floor space for one animal is 2m by 2m and 2.4m high.
- Should be sited on high, well drained ground.
- Well thatched.
- Enough bedding on the floor.

BREEDING

- The Malawi Zebu can be improved for beef breeding by crossing it with exotic breed e.g. Brahman, Charolais and Hereford.
- The bull can be used for breeding when it is eighteen months old and the heifer about 2 years.
- The recommended bull to cow ratio is 1 to 20 or 30.
- The best time of calving is about two months before the rains start to ensure plenty of fresh grass.

CARING FOR CALVES

- Calves are weaned after 6 months and solid feed is introduced gradually.
- Some husbandry practices that are done before weaning the calves are shown in the table below.

Practice	Meaning	Importance	How it is carried out, equipment required and timing.
Castration	Removal of testes	• Animals fatten quickly • Prevents inbreeding • Makes animals docile • Improves the quality of meat	• By using a knife or elastic band (elastrator) • Burdizzo to crush the spermatic cord. • Done just before the calves are weaned at six months.
Disbudding	Stopping the growth of horn buds	• Makes animal safer to handle. • Prevents the animals from hurting each other and the people looking after them. • Easy movement in thick vegetation	• Caustic soda (highly corrosive alkaline chemical) • Dehorning iron
Dehorning	Removing the horns from the cattle.	• Protects the cattle. • Protects other cattle people.	• A hot dehorning iron. • A saw
Branding	Placing an identification mark or number on the animal.	• For ease of identification • Closely monitor performance	• Cold (frozen) or hot dehorning irons are passed onto the skin of the animal, leaving or burning the numbers into the skin.
Tagging	Putting of tags on ears on both young and old	• Identification to take records • Assess performance of each animal for decision making	• Numbers or letters are attached to ears

PROTECTING CATTLE FROM DISEASES AND PARASITES.

isease	Causal organism and mode of transmission	Symptoms	Control
st Coast ver	• By protozoa, transmitted by brown ear tick and red tick.	• High temperature • Loss of appetite • Excessive salivation • Diarrhea.	• No treatment • Restrict movement of cattle(quarantine) • Control ticks by dipping cattle.
ot and outh	• By virus	• High fever • Blisters on the tongue, in the mouth and on the skin. • Lameness • Difficulties on eating.	• No treatment. • Restrict movement. • Slaughter and burn infected animals. • Vaccinate all other animals.
astitis	• By bacterial, spread through teat canal.	• High fever • Swollen udder and teats • Blood/pus stained milk.	• Antibiotics e.g. tetracycline, penicillin. • Hygiene during milking.
uberculosis B)	• By bacteria spread through contact (inhaling dropolets)	• Temperature fluctuations • Animal loses weight and gets diarrhea • Persistent coughing	• Vaccinate young animals with BCG vaccine. • Test with tuberculin and slaughter animals that are positive.

		• Thick white vaginal discharges • The animal may become sterile.	
ypanosomia s (Nagana)	• By protozoa (trypanosomes) spread by tsetse flies	• Frequent fever • Dullness • Anaemia • Death may occur	• Treat with suitable drugs e.g. berenil • Control tsetse flies by spraying • Slaughter badly infected animals.
ucellosis Contagious ortion)	• By bacteria, spread through contact and can also attack humans.	• Abortion • Genital organs in cows are inflammed	• No treatment • Slaughter affected animals. • Vaccine remaining stock.
eart water	• Caused by bacteria, spread by bont ticks	• High temperature • Convulsions or fits • Death	• Treat with antibiotics • Controlling ticks by dipping cattle

PARASITES

1. External Parasites

- External parasites of cattle include ticks and tsetse flies.

TICKS

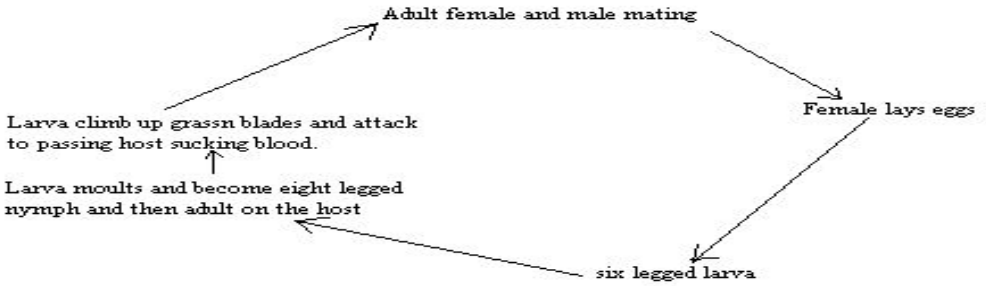
- Ticks can be found under the tail, around the scrotum and udder, on the sides of the body, in the ear, dewlap, on the neck and face, around ears, anus, vulva and tail brush.
- Ticks damage cattle in the following ways:
  1. Suck blood causing anaemia.
  2. Damage hides through their biting wounds.
  3. The bite wounds may become a source of infection e.g. mastitis.
  4. The ticks weaken the cattle and this affects production.
  5. Ticks transmit four tick borne diseases:-East Coast Fever (ECF), Heart water, red water and gall sickness.

GROUPS OF TICKS

- Ticks can be grouped into: one host ticks, two host ticks and three host ticks.

THE ONE HOST TICK

Complete their lifecycle on one animal.



THE TWO HOST TICK

- The larvae and nymph stages take place on the first host.
- The nymphs drop to the ground, moult into adults which climb onto the second host. The female and male ticks mate and the female drops onto the ground to lay more eggs.

THE THREE HOST TICK

- The larvae, nymph and adult stages complete their lifecycles on three different hosts.

Control of ticks

1. Dipping and spraying
2. Hand picking if not too many.

3. Practicing rotational grazing.

2. TSETSE FLIES

- Tsetse flies irritate and weaken the animal.
- They transmit diseases e.g. Trypanosomiasis.
- They can be controlled by spraying and clearing bush.

INTERNAL PARASITES

Parasite	Damage caused/ sign of attack	Control
Roundworms	• Attack the intestines and absorb digested feed from the animal. • Enlarged stomach (pot belly) especially on calves. • Slow growth. • Continuous diarrhea (scouring)	• Animals to be regularly dewormed by drenching with Phenothiazine or Piperazine. • Rotational grazing.
Tapeworms	• Affect the small intestine and suck digested feed. • Larvae enter the blood stream and settle in the muscles making the meat look "measly" • Can also affect humans who eat infected meat.	• Dose the animals with suitable drugs • Practice rotational grazing.
Liver fluke	• Attack the liver • Cause general weakness and internal breeding in animals.	• Destroy the snail which is the intermediate host using copper sulphate. • Avoid grazing animals on wet dambos. • Practice rotational grazing.

METHODS OF CONTROLLING PARASITES AND DISEASES

A. **VACCINATION** . The administration of vaccine into an animal 's body to confer its immunity against a particular disease. The vaccine causes the production of antibodies which help combat disease causing organism (pathogens)

B. **DEWORMING** . The administration of drugs to livestock to control internal parasites (endoparasite) infection. Deworming can be carried out by either dosing or drenching.

C. **DIPPING** . Animals are Dip washed (completely immersed) or thoroughly wetted) is to control external parasites (ectoparasites). Dipping can use plunge dip, hand spray) and spray race

MARKETING BEEF CATTLE

- Beef cattle are sold at butchers or at cattle markets established throughout the country.

BEEF GRADES

(i) Feeder grade

- Given to young animals weighing up to 225kgs which are fit for further intensive feeding.

(ii) Standard grade

- Cows, steers and bulls that look well fleshed and in good condition.

(iv) Commercial grade

- Cattle that are on fairly good condition.

(v) Inferior grade

- All cattle below the above grades.
- Once the animals have been graded a guaranteed minimum floor price, Cold storage companies, butchers and other buyers begin to bid for the animals being sold.
- If not bought, Cold storage buys at the guaranteed minimum price.

DAIRY PRODUCTION

- Dairy production refers to the practice of keeping animals especially cattle for ilk production.
- The Malawi Zebu cattle have low genetic potential for milk production. Efficient milk production requires a high level of management.

IMPORTANCEOF DAIRYPRODUCTION IN MALAWI

1. Dairy products are nutritious food with all the food nutrients include protein, carbohydrates, fats, minerals, and vitamins, as well as rich in calcium, sodium, .
2. A source of reliable income from selling milk locally or to companies that process milk.
3. Source of raw materials into many finished products such as cheese, chambiko, yoghurt, ice cream, butter and ghee as well as leather, bone meal from hides and bones.
4. Cows provide a source of manure for improving soil fertility.
5. A source of employment for people who work on dairy farms and in companies that process milk .

CHARACTERISTICS OF DAIRY CATTLE

1. The body of the cow is lean and angular.
2. The body is wedge shaped.
3. A dairy cow has a very large udder with teats which are evenly spaced.
4. The legs are short and strong to support the udder.
5. High fertility to enable it calve regularly.
6. Larger udder to accommodate more milk
7. The body does not have much flesh as genetically they convert pasture towards the udder

CHARACTERISTICS OF MALAWI ZEBU

1. A Malawi Zebu withstands the high temperature prevalent in the tropics. They are heat tolerant. They have many sweat glands.
2. Are able to walk long distances in search of food and water.
3. Indigenous cattle are better converters of roughage into utilizable products.
4. They are tolerant to tick borne diseases.
5. Can breed regularly up to 15 years of age.
6. Local animals are hardy animals-can withstand adverse conditions.

SOME EXAMPLES OF DAIRY BREEDS

Breed	Origin	Colour	Milk yield (kgs)
Friesian	Holland	Black and white	5,000
Guernsey	England	Fawn	4,300
Jersey	England	Brownish	3,500
Aryshire	Scotland	Red and white	4,000

FACTORS THAT AFFECT MILK YIELD

1. Age of animal-the milk increases with each calving up to the fifth lactation.
2. Nutrition or feeding-proper feeding with more concentrates increases milk yield.
3. Character of the cow-the quieter the temperament of the cow the more it produces milk.
4. Health –diseases such as Mastitis and milk fever reduce the quantity and quality of milk produced.
5. Season/time of the year as rainy season food is more nutritious.
6. Period of lactation-the cow dries off every 305 days after calving (10 months of lactation)

7. Milking frequency –the recommended frequency for most cows is twice a day.
8. Treatment of the cow-treat the cow gently lest the milk may be held up.
9. Milking techniques-complete milking 8-10 minutes as this coincides with the milk let down period.

MANAGING DAIRY COWS

- Wash all the milking equipment.
- Wet bedding should be removed and be replaced by fresh bedding.
- Milking shed should be 1.8m × 2.7m and 1.5m high.
- A rough concrete floor easy to clean.
- A separate room for storing feed, drugs and utensils.
- A neck yoke for restraining the cow during milking and feed troughs should be provided.

MILK HYGIENE

- Wash all the milking equipment.
- Wash udder and teats.
- Wash hands.
- Put milk through a paper filter into the funnel to remove any dirt or impurities.
- Weigh the milk and record the production per cow e.g. 1kg of concentrates to 3kg of milk.
- Give some concentrates to animals while the animal is being milked.
- Check for Mastitis (clots appear in milk)-dry cow therapy.

BREEDING DAIRY COW

- This aims at a cow producing a calf annually or two calves in three years.
- The dairy cows should be mated during the second or third month (60-90 days) after parturition (giving birth)
- Mate cows so that calving should coincide with availability of grass.

SERVICING COWS

- Cows come on heat every 21 days.
- Gestation period is about 283 days.
- Mate Zebu cows with Friesian bulls to get hybrid cows.
- Cows will let down the milk first milk during the first three to four days (colostrum)
- Lactation on cows is 10 months and it dries up the last two months before calving.
- Steaming up – refers to giving cows concentrates two months before calving to build her body for calving and sustain the foetus.

CALF REARING

- Allow calves to suckle three to four days to get colostraum.
- Calves are fed from buckets for up to three months when they are weaned.
- Foster mothers are cows spared to suckle 2-3 more calves in addition to her own calf.

Importance of colostraum to new born calf

i. it is highly nutritious as is rich in proteins, vitamin A, vitamin D, vitamin E, minerals and fats
ii. it is highly digestible hence suitable to newborns
iii. rich in antibodies which pass immunity from mother to calf
iv. has a laxative effect which clears the first faeces from the digestive system

FEEDING DAIRY COWS

- During the dry season supplement grass with crop residues (maize stover, groundnut haulms e.t.c.) and conserved grass (hay or silage)

- For maintenance provide roughage 3-4kgs live weight per day.
- Concentrates are given at the rate of 1kg to 3kg of milk produced.

DESEASE AND PARASITE CONTROL IN COWS

1. MASTITIS

- This is caused by bacteria and bad milking practices.

Symptoms

1. Swollen and inflamed udder.
2. Blood pus in milk.

Control

1. Treat with antibiotics e.g. penicillin
2. Cleanliness and hygiene during milking.

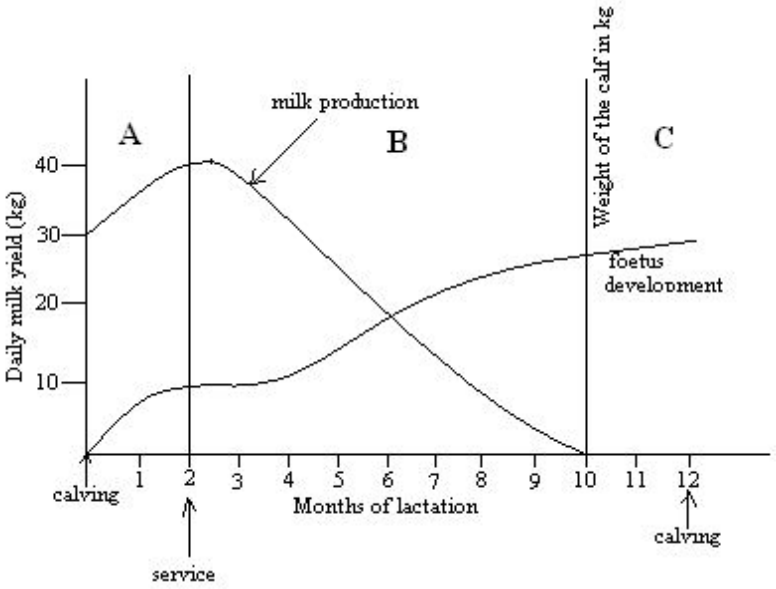
2. MILK FEVER

- This is caused by low level calcium in the blood stream and excessive production of milk soon after calving.

Symptoms

1. Paralysis and unconsciousness
2. The animal lies down and has difficulties in getting up.
3. Death in severe cases.

THE LACTATION CURVE



- Stage **A** represents early lactation, two months after calving. The milk yield is increasing steadily until a peak is reached. The cow is not in calf.
- Stage **B** represents mid lactation; the milk yield is steadily declining. The cow is in calf for a period of seven months.
- Stage **C** represents the dry period when the cow is not being milked. The unborn calf grows very rapidly. The cow should be particularly well fed in stages A (flushing) and C (steaming up).

REPRODUCTIVE SYSTEM OF A CATTLE AND POULTRY

REPRODUCTIVE SYSTEM IN CATTLE

Reproduction is the process by which new individuals are produced through fertilization.
Fertilization is the union of male and female gametes.
A reproductive system is a network of organs and accessory glands which work together to achieve reproduction.

TESTICLES - They are two ovoid and glandular organs enclosed in the scrotum.
They produce spermatozoa (male gametes). Testicles also secret male sex hormones called testosterone.
Sperms are actually produced by seminiferous tubes in the testicle.
SCROTUM – A thin, distended skin or sac which suspends the testicles outside the body cavity between the hind legs providing ideal temperature for sperms development. This is because sperms are produced at a slightly lower temperature than that of the body. It is also a protective skin for the testes.
EPIDIDYMIS - A large coiled tube attached on one part to each testicles. It stores the sperms produced in the tubules.
VAS DEFERENS (SPERM DUCTS) VAS DEFERENTIA (SINGULAR)
They carry the sperms from the testicles to the seminal vesicles (urenthra).

URETHRA- A canal that extends from the vas deferens to the end of the penis.
It serves as a passage for both semen and urine into vagina and outside the body respectively.
The discharge of the sperms from the penis into the female organ is called ejaculation. The sperms swim in the semen fluid to the fallopian tubes where fertilization of the egg takes place.

PENIS- An organ that penetrates into the vagina during mating (The penetration of the penis into the vagina is called copulation)

GLANDS. They include
b. Cowper's gland- produces a mucoid fluid that precedes the sperm and helping to neutralize the acidity of the urine in the urethra which is harmful to the sperms.
ii. Prostate gland- produces a saline glucose rich in fluid that activates the sperms.
iii. Seminal vesicles- produce seminal fluid in which sperms are carried.

REPRODUCTIVE SYSTEM IN FEMALE CATTLE
VULVA - An external opening of female reproductive system. It conducts urine outside and receives the penis during copulation.
VAGINA - A female corpulatory organ where sperms are deposited.
-It also serves as a birth canal and passage for urine from the bladder.
CERVIX - Consists of thick muscles which separate the uterus from the vagina. It only opens two times, when an animal is on heat to allow entry of sperms and is also wide when an animal is giving birth.

UTERUS / WOMB - Has walls where a fertilized egg (zygote) is implanted and then grows into embryo and lastly into foetus. The uterus has membranes
v. foetal membrane which attach developing embryo on the uterine wall
vi. placenta which nourishes (feed) the foetus.

OVIDUCT / FALLOPIAN TUBE- Where fertilization takes place. It also assists in the movement of the eggs to the uterus.
OVARIES – They are two oval -shaped organs which produce female gametes (eggs or ova). The process of releasing eggs is called ovulation.
The other function of ovaries is to secret the sex hormones, oestrogen and progesterone.

Each egg is surrounded by a Graafian follicle, which matures and ruptures (breaks) when the egg is released into the oviduct (fallopian tube). The ovary hole (when an egg is removed) is filled by Corpus luteum which prevents the release of other ova. The corpus luteum also produces progesterone hormone that helps the process of ovum implantation in the uterus and the development of udders (mammary gland).
If the egg is fertilized, the corpus luteum is retained for the whole gestation period, and the corpus leutem degenerates if fertilization has not taken place.

NAME OF HORMONE	PLACE WHERE PRODUCED	FUNCTIONS
Follicle stimulating hormone (FSH)	Pituitary gland (in the brain)	-Stimulates the growth of follicles - Stimulates the development of ovaries
Oestrogen	Follicle and developing ovary	-brings about oestrus (onset of heat) -influences the pirtuitary gland to produce luteinizing hormone. -influences development of mammary glands.
Luteinising hormone (LH)	Pituitary	-stimulates rupture of follicle to release eggs. -initiates production of corpus luteum essential for the maintenance of pregnancy.
Progesterone	Corpus luteum and placenta of pregnant animal	-stimulates follicle development -influences development of ovary - influences development of mammary glands -influences the development of uterine walls. -inhibits ova production if animal is pregnant.

THE REPRODUCTIVE ORGANS OF A HEN

PART/ SECTION OF THE OVIDUCT	SUBSTANCES ADDED/ FUNCTION
Infundibulum (funnel)	Where eggs are fertilized / where sperms are stored after mating with a cock
Magnum	Where albumen is added
Isthmus	Where egg membranes, mineral salts and water are added.
Uterus (shell gland)	Where the shell is added (takes 18 – 21 hours)
Vagina	Where pores in the egg are added
Cloaca or vent	Where the egg is passed out (oviposited)

FACTORS AFFECTING QUALITY OF THE EGG SHELL

a. length of Time in Lay

the longer the bird is in lay, the weaker the shells will become because of her inability to obtain daily enough calcium from her diet to supply all of her nneds for one egg.

b. Increased environmental temperature results in reduced food consumption (and calcium) due to panting.
c. Egg laying time. early laying in the morning has thinner shells as at night animals were not eating to obtain enough calcium.
d. Stress as stresses birds lay thinner shelled eggs.
e. Disease as certain diseases such as infectious bronchitis cause weak shell and misshapen eggs.
f. Certain drugs influence eggshell formation and deposition

THE REPRODUCTIVE SYSTEM IN CATTLE

PUBERTY - A stage of sexual maturity or reproductive competence in animals. This is where a female animal starts developing ova and the males produce sperm, heat period set in, and ovulation occurs.
It is controlled by hormones, testosterone in males which controls the maturation of reproductive system and production of sperms and the desire to mate. In females, the hormone oestrogen controls the maturation of the reproductive system, egg development and ovulation.

FACTORS THAT AFFECT THE RATE AT WHICH ANIMALS REACH PUBERTY

c. Type of breed (Genetics). Different animals reach puberty differently. For example, animals like Jersey reach puberty earlier than Friesian.
d. Animal type. Dairy cattle reach puberty earlier than beef cattle.
e. Cross breeds reach puberty earlier than pure breeds due to heterosis.
f. Environmental factors like drought, scarcity of water, feed may delay puberty.
g. General management especially on proper feeding/ nutrition and disease control induces puberty earlier than those poorly managed.
h. Exposure to opposite sex. Animals exposed to opposite sex (mating) reach puberty earlier than those raised in same sex groupings, due to pheromone effect.
i. Body weight also influence more than age as daily cattle reach puberty when they have attained 30 – 40% of the adult weight, while beef cattle at 45 – 55% of the adult weight and sheep at 40% - 50 %.
j. Warmer temperatures lead to earlier puberty while extreme of temperature delay it.
k. Exotic breeds reach puberty earlier than indigenous breeds.

OESTROUS CYCLE. It is a period between two successive heat periods in animals

The knowledge of oestrous cycle in cows is necessary for a farmer to carry out a successful breeding programme, especially making sure that mating is done at the right time.

PHASES OF OESTROUS CYCLE IN COWS

1. **PROESTROUS.** (17 – 20) The regression of corpus luteum where reproduction tract is prepared like growth of follicles development of muscles of the ovary and thickening of vaginal and vulva walls. This is due to increase in production of oestradiol, a hormone produced by oestrogen.
3. **OESTROUS.** (Day one of new cycle) The dominant follicle matures and ruptures releasing the ovum. The ovulation is induced by high concentration of luteinizing hormone. Animal shows signs of heat.
4. **METOESTROUS** . (Day 2 – 4) Corpus luteum is formed through hormone progesterone which suppresses growth of follicles to prevent release of another egg.
5. **DIOESTROUS** (Day 5 – 17) Period of maximum corpus luteum size and function if fertilization takes place and animal is pregnant.

HEAT PERIOD. A period of sexually receptive, where an egg is mature and an animal is ready for mating.

SIGNS OF HEAT

1- Restless as animal looks for a male
2- Vulva swells and become enlarged
3- Mucus discharges from the vulva
4- Reduced appetite
5- Mounting other animals and stand still when mounted.
6- Cow bellows or moos unnecessarily

7- Drop in milk yield
8- Frequent urination
9- Slight rise in temperature
10- Cow sniffs other animals on the vulva and allows others to sniff them.

TRADING IN AGRICULTURAL COMMODITIES

- Trading refers to buying and selling at a profit.
- Marketing is a process that involves the identification of consumer needs and then satisfaction of these needs. Consumer needs are identified through conducting marketing research and are satisfied through grading, processing, transporting, storage, risk bearing and buying and selling at a profit.

Marketing	Trading
Covers a broad rang of activities (marketing functions)	Covers a narrow range of activities basically buying and selling.
Stresses consumer analysis and satisfaction	Stresses sales
Follows a long term orientation (beginning with market research and ending with exchange of goods)	Follows a short term orientation that begins and ends with the exchange function (buying and selling)
Uses selling as a means of communicating with and understanding the consumers.	Uses selling as means to an end.
Directs resources of the farm to produce commodities that consumers	Directs resources to bring about a sale/purchase
Makes attempts to adapt to changes in consumer characteristics or needs i.e. changes in consumer tastes leading to changes in the commodity, to satisfy consumers.	Makes attempts to develop a stronger sales drive (changes in consumer taste may merely lead to changes in the sales strategy or pitch.
Seeks to anticipate, manage and satisfy demand at a profit.	Seeks to dispose of surplus for profit

IMPORTANCE OF TRADING OF AGRICULTURAL COMMODITIES.

IMPORTANCE AT COMMUNITY LEVEL

1. Encourages each member of the community in an enterprise that is most rewarding to him or her.
2. Everyone benefits when the producers of different commodities are able to sell their goods to one another.
3. Producers can obtain with part of their own output, more goods than they could have produced themselves with the same amount of effort.
4. Income from sales raises the living standards of all concerned and adds to the economic wealth of the community.
5. Trading promotes specialization, that is people concentrate on a particular enterprise and tend to develop more expertise (skill) in that enterprise than if they tried to do a bit of everything.
6. Trading increases productivity of the community since each member does what she/he is best suited to do.
7. Trading promotes efficient division of labour, which saves time.
8. Trading provides outlet an outlet (vent) for surplus from farm holdings in the community.

IMPORTANCE AT NATIONAL LEVEL

1. Trading creates work opportunities (employment) and economic activity which improves a countries economic stability.
2. It promotes more efficient allocation of resources such as land, labour or capital in a country.

3. It increases national output since workers are fast and more productive through specialization.
4. It enables the products of specialization in one area to be exchanged for those produced cheaply elsewhere.
5. It promotes the development of local agro-industries (value addition) through the provision of raw materials and market for its products (industries can buy raw materials and sell their processed products)
6. It enables farmers who form a majority of economically active population to convert agricultural commodities into cash income.
7. It enables urban population to obtain food.
8. It improves political stability of a country as people are seriously engaged in different forms of economic activities to earn a living.

IMPORTANCE AT INTERNATIONAL LEVEL (INTERNATIONAL TRADE)

1. Nations earn foreign currency needed for the importation of essential goods such as fuel, drugs.
2. It enables each country to import what it does not produce, using foreign exchange earnings.
3. Trading offers consumers a wider choice of products.
4. It provides incentives for production
5. It enables the country to obtain funds through taxation at the point of export and import (duties)
6. It increases business profit for those engaged in this type of wholesale trade (bulk trading)
7. It widens the market for agricultural products which encourages the use of utilized resources e.g. land and labour.
8. It creates greater pressure on farmers to be more efficient in order to compete internationally.
9. It improves international relations as countries engaged in trade maintain peace to continue benefiting from trade.

WAYS OF IMPROVING TRADING OF AGRICULTURAL COMMODITIES

AT COMMUNITY LEVEL BY

1. Promoting good neighbourliness.
2. Increasing efficiency of production to ensure a surplus from family farm holdings.
3. Promoting the development of rural growth centres, cooperatives.
4. Improving the rural infrastructures for producers or traders to transport commodities more easily.

NATIONAL LEVEL BY

1. Improve transport infrastructure network e.g. road, rail and lake transport.
2. Promoting peace
3. Providing adequate marketing information (marketing news)
4. Removing surtax on agricultural commodities and inputs.

AT INTERNATIONAL LEVEL BY

1. Promoting good international relations (peace).
2. Increasing transport and storage facilities a t ports of entry
3. Improving advertisement and sales promotion e.g. trade fairs.
4. Competitive pricing-reasonable prices
5. Establishing a stable and competitive exchanging rate.
6. Improving the quality of agricultural products to attract external buyers e.g. quota system.
7. Providing adequate information to potential exporters about international markets, the customers and procedure.

8. Reducing or removing barriers to trade such as tariffs, import quotas, exchange controls, embargos and other technical barriers.

Note:

Embargos - is ban on all trade in a particular commodity.
Tariffs –tax placed on imports.
Import quota – limit on quantity of goods allowed into the country.
Exchange control – limit on the amount changed into foreign currency.
Technical barriers – regulations that make it difficult for foreign producers to sell their products.

AGRICULTURAL COOPERATIVES

A cooperative is an organization or group of people who join together to pool their resources and services to achieve a common goal.

BENEFITS OF AN AGRICULTURAL COOPERATIVE TO THE FARMER.

a. Produce or market commodities cheaply because of the resources available and shared expertise.
b. Secure much needed loans from commercial banks.
c. Buy inputs e.g. fertilizers and seeds cheaply since the society is able to buy these in bulk at wholesale price.
d. Make use of expensive machinery such as a tractor which an individual farmer would find it expensive to own or hire a tractor.
e. Benefit from economies of scale-they are able to keep the overhead costs low since these are shared.
f. Transports their produce to markets more easily.
g. Bargain for better prices or selling conditions as a group.
h. Sell commodities and share proceeds accordingly.
i. Take advantage of storage and processing facilities by sharing these.
j. Quickly adopt innovations in agriculture by sharing expertise and knowledge.

PRINCIPLES FOR FORMATION OF COOPERATIVES.

a. A cooperative should be legally constituted with guiding rules and or regulations.
b. Participation is voluntary. People are free to join or withdraw.
c. Cooperatives are impartial and not base on political or religious grounds.
d. A cooperative is open to all family community members who share common interest.
e. Organized and democratic – one person one vote.
f. A committee of up to ten members consisting of a chairperson, secretary, treasurer and committee members.

FACTORS THAT MAKE AGRICULTURAL COOPERATIVE SUCCEED.

a. The staff and committee members have the necessary expertise and are trustworthy.
b. Enough capital/funds.
c. Efficiently and effectively organized.
d. Staff members managing funds are skilled trustworthy and highly motivated.
e. All members are committed to the cooperative and its success.
f. Adequate infrastructure (staff houses, offices, storage facilities), personnel, transport, equipment and supplies.
g. Members receive ongoing and relevant training to improve their productivity and marketing skills.

FARM BUDGETS

- A budget is an estimate of future expenditure and income.

- Farmers budget to estimate their expenditure and to forecast (predict) their income after sales.
- Budgets provide a useful yardstick against which farmers can measure their activities.

TYPES OF BUDGET

1. PARTIAL BUDGET

- This is a budget that affects only part of a farming system.
- It is used to evaluate or assess change to art of a farming system. For example a farmer may decide to use chemical fertilizer instead of manure.
- When preparing a partial budget consider
  (i) What extra costs to be incurred?
  (ii) What present income is to be foregone or given up?
  (iii) What extra income is to be earned?
  (iv) What existing present costs are to be saved?
- By adding up answers to questions 1 and 2, the farmer will arrive at the total costs of the proposed change.
- Answers to questions 3 and 4 provide the figure for the total income.

Costs /Loss	**Income/Gains**
1. Extra costs	3. Extra returns
2. Present income sacrificed	4. Saved costs
Total costs =	**Total income =**

- If the costs are more than the income, then the proposed change will not be profitable.
- If the income outweighs the costs, the change profitable.

USES OF A PARTIAL BUDGET

- A partial budget is used when a farmer wants to:
  (i) Expand the existing enterprise or make additions to the existing enterprises.
  (ii) Change one enterprise for another – substitution.
  (iii) Introduce a new enterprise.
  (iv) Buy a new farm machinery or equipment.
  (v) Adopt a change in method of production e.g. use machinery instead of hands.
- The major weakness of the partial budget is that it does not consider all the costs (variable and fixed)

Question

A farmer has 2 hectares of land on which he/she grows MH18. He/she however plans to make the following changes:

- To apply 4 bags of urea instead of 6 bags at K1, 300.00 per bag.
- To sell 40 bags of maize at K1000.00 per bag to Chibuku products instead of K850.00 to ADMARC.
- To store maize in 50 sacks at K30.00 each instead of storing it in a nkhokwe.
- To spend K500.00 instead of K300.00 on Superguard dust.
- To spend K600.00 per hectare instead of K300.00 per hectare on casual labour.
  (i) Prepare a partial budget for this farmer.
  (ii) Should the farmer go ahead with his/her plan?
  (iii) Explain the major weaknesses of this partial budget.

2. COMPLETE BUDGET

- This is a type of budget which examines the effect of changes made to the whole farm.

- It is prepared when a farmer;
  1. Is opening a new farm.
  2. Intends to carryout major reorganization of the farming system.

STEPS A FARMER SHOULD FOLLOW WHEN PREPARING A COMPLETE BUDGET

(i) Make an estimate of what is possible to produce.
(ii) Estimate the expected yield of crops, output of farm animals.
(iii) Estimate the input requirements for both crop and animal production.
(iv) Estimate prices of output and input costs (variable costs)
(v) Estimate the cost of permanent labour, machinery and equipment (fixed) costs.
(vi) Estimate other fixed costs e.g. depreciation of buildings and equipment.
(vii) Calculate the total costs, total returns and profit from the plan.

Gross margin is the amount of money that is left after variable costs are subtracted from the gross income of an enterprise. It is calculated per hectare for crops and per head for animals.

Table below shows Gross Margins/hectare for some crops.

	MAIZE	**RICE**	**G/NUTS**	**COTTON**
Yield (kg/ha)	3,000	1,500	450	800
Price (t/ha)	47	90	198	100
Gross income (MK)	1,1410.00	1,350.00	891.00	800.00
Variable cost (MK)				
Seed	100.00	67.50	250.20	5
Fertilizers	398.00	568.98	-	-
Pesticides	36.72	21.60	-	160.00
Casual labour	100.00	75.00	150.00	300.00
Total Variable Costs (MK)	634.90	733.08	400.20	465.00
Gross Margin/ha (MK)	775.10	616.92	490.80	335.00

Gross income (Total Revenue) = Quantity × Price.
Gross Margin = Gross income – Total Variable Costs
Profit = Gross Margin – Total fixed costs or TR – (TVC – TFC)

Question

A farmer planted a hectare of tobacco and kept the following records.

Land tax	2,000.00
Electricity bills	1,000.00
2 bags of CAN at K1500.00 per bag	3,000.00
Cost of seeds	500.00
Depreciation cost of sprayer	400.00
Wages of permanent labour	10,000.00
Cost of casual labour	4,000.00
Insecticides	1,000.00
Price of leaf per kilogram	80.00
Yield of tobacco leaf	500kgs
Sale of tobacco stems to a vegetable farmer	2,000.00

a. Classify the records into variable and fixed costs.
b. Find gross margin and profit for this farmer.

FARM MECHANIZATION

- Farm mechanization is the use of hand-operated tools, animal drawn equipment, motorised implements and other devices such as solar energy.

FACTORS TO CONSIDER WHEN MECHANISING A FARM

a. Size of the farm holdings-farm mechanisation require large farms, land that is consolidated. It is not suitable for small and scattered farm holdings i.e. land that is fragmented.
b. Accessibility of the land. The land should be reachable to machines such as tractors.
c. Topography of the land-use of machines needs flat land.
d. Availability of capital-it requires sufficient capital to buy machinery or implements and spare parts.
e. Technical know-how. There should be skilled labour to operate, maintain and repair the machines.
f. Value of the crop. The crop to be grown under mechanisation should be of high value in order to recover the costs of mechanisation.
g. Market demand-there should be a high demand for the crops that are to be under mechanisation.
h. Farmer's attitude. Farmers should have a positive attitude towards mechanisation.
i. Availability of spare parts –it is essential that the spare parts of the machinery must be readily available.
j. Availability of fuels and oils.
k. Availability of labour-certain jobs are best done by people.
l. Land for animal feed where ox-drawn implements are used.
m. Farming practices such as crop diversification may limit the size and efficiency of machinery to be used.
n. Infrastructure- should be adequate infrastructure e.g. roads, rural electrification, market system and water supply.
o. Availability of credit facilities to buy farm machinery.

ADVANTAGES OF FARM MECHANISATION

a. Farm operations are done faster and the right time e.g. operations such as ploughing, planting, weeding and harvesting.
b. It leads to increased production-total yields are high as a result of large scale operations.
c. It makes work easier. It reduces drudgery. Difficult jobs can be done e.g. clearing large forests or cultivating the soil when too dry.
d. It releases farmers ' time for other tasks.
e. Farmers benefit from economies of large scale operation because of large areas covered. Cheaper to produce a commodity per unit quantity or unit area.
f. Fragmentation is discouraged.
g. Pests, diseases and weeds are minimized. Weeds are buried and some pests exposed to die while others are suffocated as they are buried.
h. Efficiency-a better job (high quality job) is done mechanically than using human labour.

DISADVANTAGES OF FARM MECHANISATION

a. Unemployment is created-mechanisation may take the place of farm labour causing seasonal labour surpluses.
b. Quality of work may be poor due to the speed of operation.
c. Capital and operating costs are very high.
d. Loss of valuable foreign exchange since tractors, spare parts and fuel are imported.
e. It requires skills to operate and maintain machines.
f. Soils are compacted due to use of heavy machines. This causes poor drainage and poor root growth.
g. Some crops are not easily mechanised and this limits the choice of crops to be grown.

FARM OPERATIONS

- These include cultural practices such as clearing the land, land forming, primary cultivation, secondary cultivation, maintenance and harvesting.

PRIMARY CULTIVATION

- This is primary tillage that refers to the opening of a virgin soil (the first operation after land clearing)
- Ploughs are used for initial breaking up of the land (ploughing) – primary tillage.
- Disc plough is ideal for tropical conditions. It is able to roll over objects or obstacles such as rocks and stumps.
- Mould board plough easily breaks because hence the land should be cleared of stumps and stones or boulders.
- Primary tillage is needed to promote a sufficient depth of soil for good water percolation and retention, root development, for aeration and to kill weeds by damaging their roots.

SECONDARY CULTIVATION

- This refers to all operations aimed at seedbed refinement.
- Harrows are used to break up down large slumps of soil and level the ground.
- Harrows are also used to incorporate manure or organic matter into the soil.
- The objectives of secondary tillage are:-
  1. To break up large clods to obtain a fine tilth.
  2. Control weeds, pests and disease.
  3. Improving soil aeration and covering broadcasted seeds.

TYPES OF FARM MACHINERY

- Farm machinery can be classified into:
  1. Farm implements that use human power e.g. a cotton sprayer.
  2. Ox-drawn implements e.g. a mouldboard plough and a ridger.
  3. Tractor drawn machines e.g. a disc plough and harrows.
- Table below summarises the uses of some farm implements and ox-drawn or tractor-drawn machinery.

Implement	**Use**
Plough	Mostly for ploughing and tilling.
Harrow	Breaking down the clods, leveling the land and incorporating manure into the soil.
Ridger	Making ridges
Cultivator	Weeding
Ox-cart	Transporting produce, manure and people.
Cotton or garden sprayer	Spraying insecticides and fertilizers onto vegetables and cotton plants
Wheelbarrow	Transporting equipment, manure, farm produce
Hoe	Tilling
Panga	Felling trees

MAINTENANCE OF FARM MACHINERY

- Properly maintained machinery works better and is safer to work with.

(a) Implements using human or animal power

a. Use each implement properly by putting it into its proper use.
b. Clean the tools and implements after use.
c. Lubricate all moving parts to reduce wear and tear.

d. Tighten all bolts and nuts.
e. Replace worn-out parts.
f. Repair worn-out parts and sharpen blunt parts.

(b) Tractor drawn implements

a. Tighten loose bolts and nuts
b. Grease and oil all movable parts.
c. Replace worn-out parts.

Table below shows how to maintain some of the farm machinery.

Implement machinery	Method of maintenance
Hoe	▪ Check that the handle is in good order ▪ Check that the blade is not blunt ▪ Sharpen the blade if blunt ▪ Scrape oil off the blade ▪ Apply some waste oil to the blade and store it in a dry place.
Panga	▪ Replace the short handle if broken ▪ Sharpen the blade if blunt ▪ Clean the panga ▪ Oil the blade and keep it in a dry place
Wheelbarrow	▪ Grease the wheel axle to reduce wear and tear. ▪ Paint the barrow to prevent rusting.
Sprayers	▪ Clean the tank after use with lots of clean water to prevent corrosion caused by insecticides and fertilizers. ▪ Dismantle and clean the nozzles thoroughly. ▪ Replace piston cups and worn out nozzles. ▪ Paint the knapsack sprayer during the off-season.
Ox-plough and ridger	▪ Grease the axles, the hake/regulator and the hitch. ▪ Tighten loose bolts and nuts ▪ Set the plough and ridger correctly. ▪ Do not drag the plough and ridger when transporting them, to prevent corrosion. Better still; carry the plough or ridger in an ox-cart. ▪ Replace worn out parts such as land slide and share.
Ox-cart	▪ Grease wheel bearings and hub ▪ Tighten loose bolts and nuts ▪ Replace worn out parts. ▪ Check that the tyres are at the correct pressure. ▪ Replace worn out tyres. ▪ Do not overload the ox-cart to prevent it from overturning. ▪ Paint the ox-cart and store it in a shed to prevent it from rusting.
Mouldboard plough	▪ Check the share and the coulter. ▪ Sharpen the share if blunt ▪ Lubricate the coulter bearings daily. ▪ Grease the mouldboard share and landslide to prevent rust ▪ Paint beams
Disc plough	▪ Tighten bolts and nuts ▪ Grease the bearings ▪ Clean and adjusts the discs. ▪ Replace worn out discs. ▪ Oil the disc plough after use to prevent it from rusting. ▪ Paint the beams
Harrows (spike toothed and spring toothed)	▪ Tighten all bolts and nuts ▪ Grease the bearings ▪ Check that the teeth are securely in place. ▪ Tighten the U-bolts ▪ Replace worn out parts ▪ Grease the harrow when not in use to prevent it from rusting.
Tractor	Ensure that: ▪ The tyres are at the correct pressure ▪ The plates in the battery are covered by acid. ▪ There is enough water in the radiator

	▪ The engine oil is regularly replaced. ▪ There are no oil leaks ▪ The tractor has enough fuel.

SAFETY MEASURES TO BE OBSERVED WHEN USING FARM MACHINERY

a. When spraying wear protective clothing.
b. Wash your body thoroughly with soap after spraying.
c. Do not smoke or eat when spraying crops.
d. Avoid spraying against the wind. When carrying implements ensure that the sharp blades face downwards to prevent accidents.
e. Keep children away from working machines.
f. Do not overload the wheel barrow and oxcart.
g. Fuels and oils should be kept in safe place, because they are highly inflammable.
h. Check the steering and the brakes of the tractor so that they do not fail.
i. Switch off the engine of the tractor when fuelling it or servicing it.

LAND DEGRADATION AND THE ECONOMY

Land degredation is the gradual transformation of a previously productive and valuable land into a non- productive and useless land.

FACTORS THAT LEAD TO AN INCREASE IN LAND DEGRADATION

1. Rapid population increase, increase the demand for land for cultivation, housing, and industrial development leading to scarcity and value of land (becoming expensive).
2. Poor farming practices such as cultivation on marginal lands leading to soil erosion.
3. Poverty that makes people to exploit forest resources for a living.
4. Greed, where people are unlawfully practice deforestation to enrich themselves.

HOW LAND DEGRADATION AFFECTS THE ECONOMY

a. The loss of top fertile soil leave the land unproductive leading to low production of crops and livestock.
b. The low levels of production lead to loss of foreign exchange due to low export as well as import of livestock and crop produce to cover for the deficit.
c. The low income of families may lead to low standard of living due to poor housing, poor feeding and poor education as they may not afford quality education for their children.
d. A society with low standard of living may not access quality food leading to poor health, ill health, starvation and death. An unhealthy society cannot fully be engaged in economic activities like in agriculture.
e. Siltation of water bodies such as rivers and dams, affects the generation of hydropower.
f. Pollution of water leads to death of aquatic organisms mainly fish, thereby affecting the livelihoods of people along the shores of Lake Malawi. Air pollution also contributes to ill health
g. Damage of infrastructure such as roads, railway, and water systems may cut off an area from the rest thereby interfering with transport and communication. This may affect the transport of inputs and farm produce and make government incur a lot of expenses in repair of such infrastructure.

FOOD SECURITY

Food security refers to the adequate production and access to the staple food by people in a country. The main staple food in Malawi is maize grown on 90% of farm land. The alternative food crops are rice, millet, cassava, sorghum, bananas among others.

WAYS OF ACHIEVING FOOD SECURITY

a. USING DROUGHT –RESISTANT CROPS.

These are crops like cassava, sweet potatoes, yams, millet and sorghum. They are important because:

1. They adapt to drought therefore they can survive even with little moisture hence withstand long dry spells.
2. They mature early before rains stop thereby ensuring adequate food supply to Malawians both in the dry season and when waiting for the main staple food to mature.
3. They are easy to store. Crops like cassava, yams and sweet potatoes can remain in the field and harvested when needed in time of scarcity. They can also be processed and stored for future use.

USING SCIENTIFIC AND TECHNOLOGICAL INNOVATIONS TO ACHIEVE FOOD SECURITY

1. **Plant and livestock breeding research** – new techniques have been developed to ensure production of high yielding crops and better livestock breeds that resist pest and disease, mature early.
2. **Irrigation technology** – this has helped to overcome drought as crops can be grown even in the dry season rather than relying on rain –fed farming ensuring high crop yield hence continuous supply of food.
3. **Fertilizer production technology** – the high analysis fertilizers are developed to improve soil nutrient thereby increasing crop yields.
4. **Stock feed manufacturing** – commercial feeds like concentrates, additives and livestock hormones have increased livestock yields as they make animal reach market weight early.
5. **Pesticide and vaccination development** - this has resulted in more effective control of pests and diseases and keeping endemic diseases at bay thereby reducing costs of crop and livestock production.
6. **Herbicides development** – development of chemical weed killers has also led to increased crop yields.
7. Food storage and preservation. Cold storage facilities for highly perishable produce like vegetables, milk and meat are used to preserve them and use them w
8. **Mechanization** – this has helped farm operations such as land preparation, planting, weeding to be completed in time that translates to increased performance of the crop. Mechanization also enables farming on a large scale since machines have high output per unit time compared to human labour.
9. **Crop processing and marketing** – this has ensured that perishable produce food such as mangoes, milk, meat is processed into products that can kept for a long time.
10. **Soil conservation and drainage** – this has made land more productive as soil erosion is checked.

LAND TENURE

Refers to the condition under which one owns land or has rights to the use of a particular piece of land.

TYPES OF LAND TENURE

a. Public land
b. Communal (customary) land
c. Private land.

D. CUSTOMARY LAND

A type of land where ownership belongs to the community with the following characteristics:

- Land is governed by customary laws
- The custodian of the land is the community head, usually the chief.
- Land is given freely
- Land is passed on through inheritance.
- The land is given by the chief.

ADVANTAGES

a. No one is landless as land is given freely as a far as he is a member of a community.
b. There is some security, provided a members is not evicted.
c. Members have freedom on the use of the land.
d. Land disputes are settled by the chief.

DISADVANTAGES

a. Land cannot be used as collateral to secure a credit.
b. No incentive to improve the land
c. Land is subdivided to children leading to uneconomic use of land.
d. Leads to land fragmentation.
e. Leads to overgrazing and improper use of land as each member is not restricted.
f. Plots are usually small, hence no benefits of large scale economies.
g. Mechanization is impossible due to fragmentation and small pieces of land.

PUBLIC LAND

The land is held and used by government for
- government building
-forest reserves national parks
- Government roads and institutions
- other national infrastructure

ADVANTAGES

- conserves natural resources
- Can be used to settle landless people.
- Allows for development of infrastructure
- Government can earn income through leasing of such land.

DISADVANTAGES

a. Land can remain unutilized for a long time.
b. High likelihood of encroachment on land by landless people.

PRIVATE LAND

It is a land that is owned by an individual or group of people that is bought hence can be sold.

a. FREEHOLD

Land that is absolutely owned by an individual or group of people, where no rent is paid.

ADVANTAGES

1. A farmer can acquire agricultural credit by using the land as collateral.
2. Soil and water conservation measures are practiced because individuals wish to benefit from the land.
3. Returns form investments are high as soil productivity is high due to conservations measures.
4. Farmer carries sound farm planning investing in long –term improvement since is the sole decision maker.
5. Land disputes are minimized.
6. The land can be liquidated or sold to raise money.

DISADVANTAGES

a. Land may remain idle, unutilized while other people are in need of land.
b. It leads to unequal land distribution, while some have big land others small.
c. Land cannot be to full use if owner does not money or skills to operate the land.
d. May be sold if a farmer has failed to pay back loan.

b. LEASEHOLD

It is land that is held for a particular use, for a specific period of time, and for a certain amount (annual rent).

THREE CATEGORIES OF LEASE

h. 21 year leases for agricultural land.
i. 33- 99 year leases for property and infrastructure development.
j. Over 99 year leases for developers.

ADVANTAGES

h. Enable people in need of land to access it for agricultural use.
i. Ensures maximum utilization of arable land as less likely to remain idle.
j. Enables the government to earn income from renting the land.
k. Benefits from economies of large scale.

DISADVANTAGES

h. It can lead to unequal distribution of land.

MALAWI POPULATION POLICY

Its goal is to improve the standard of living and quality of life of Malawians.

AIMS

a. Keeping future growth of the population within manageable and sustainable limits.
b. Reducing the rate at which population pressure on the land is growing.

The policy can be achieved through;

a. Enlightening the population on the benefits of manageable families.
b. Education for both girls and boys to make sound decision of family size.
c. Educating the citizens of various methods of family planning and making them easily available to them.

IMPORTANCE OF MANAGEALE POPULATION

a. Helps reduce pressure on available land.

b. Reduce the national demand on tree related fuels, to save existing forests from degradation.
c. Ensure protected watch catchments are safe from encroachment by the landless.
d. Ensure farms are of economically viable size by preventing land subdivision.

LAND DISTRIBUTION POLICY

1. Ensures every member has access to a plot of land through the distribution of the chief for subsistence farming.
2. Ensures farmers wishing to practice large scale commercial level have access to land through leasehold system.
3. Provides a room for government to buy idle land from estate and small holder sectors to distribute to able and entrepreneurial farmers.
4. Strengthen the rights of women and men.

EQUITABLE LAND DISTRIBUTION

It refers to the distribution of enough land according to his or her needs and abilities.

IMPORTANCE OF EQUITABLE LAND DISTRIBUTION

c. Ensures efficient utilization of land hence food security as farmers are given idle land is given to farmers involved in large scale farming.
d. Helps to remove the perennial problem of land fragmentation and land subdivision.
e. It ensures increased food production hence food security in the country.

OBJECTIVES OF NATIONAL AGRICULTURAL POLICY

It aims at improving food improving food security and produce for the export market to earn foreign exchange through:

1. Achieve and maintain self – sufficiency in food production both at national and household levels.
2. Expand and diversify cash crop production for import substitution and export.
3. Provide opportunities to all the smallholder farmers for the growing of cash crops in addition to maize and other food crops.
4. Achieve self- sufficiency in all livestock products and export any available.
5. Raise the economic and social welfare of the rural population through increased farm income.
6. Conserve the natural resources, especially soil, water, and trees, in order to improve and maintain the productivity of the land.

THE ROLES OF THE POPULATION POLICY AND AGRICULTURAL POLICY IN NATIONAL DEVELOPMENT.

1. They guide government in planning on infrastructure development, on health facilities, marketing channels, and agricultural research.
2. They guide in the distribution of agricultural services such as production credit, external services, processing among others to where they are required most.
3. Ensure that agricultural resources especially land, are conserved, and not too degraded by the rapid growing population.
4. Ensure that population growth matches the availability or capacity of the land to support it.

AGRO- BASED INDUSTRIES

Agro- based industries are a companies or firms that process agricultural products or produce agricultural inputs, tools and machinery needed in the farming sector.

INDUSTRY	RAW MATERIALS	PRODUCTS
Grain and milling Company Limited	Maize, wheat	Gramil maize meal
Lever Brothers	Groundnuts, cotton seed, sun flower	Cooking oil Butter, stork margarine
Illovo Sugar Limited	sugarcane	sugar
Chibuku Products Limited	Maize, millet, sorghum	Chibuku beer
David Whitehead and sons Limited	Cotton lint	textiles
Cold Storage limited	cattle	Beef, suasages
Malawi Dairy Industries	milk	Fresh milk, yoghurt
Press Foods Limited (Tambala Food Products	Tea leaves, groundnuts	Chombe tea, Tambala groundnuts, Superstar cooking oil
CORI (Capital Oil Refining Industries LTD	Sunflower, groundnuts, meat	Kukoma Cooking Oil sausages
Rab Processors Ltd	Rice, maize	Super Faya Rice Snow white Ufa Woyera.
BAT(British American Tobacco) Malawi Limited	Tobacco leaf	cigarettes

AGRO- INDUSTRIES THAT PRODUCE AGRICULTURAL INPUTS

AGRO-BASED INDUSTRY	INPUTS
Agrimal (Malawi) Limited	Ploughs, animal drawn ridges and cultivators, hoes and pangas
OPTICHEM (2000) Limited	Manufactures Compound NPK fertilizers, 23: 21: 0 + 4S, Super D 10: 24: 20. Direct importers of straight fertilizers Urea, CAN and Ammonia Phosphate
Pannar Seed (MW) Limited	PIPECO (Pipe Irrigation, hose pipes, borehole pumps, spare parts
Agricultural Trading Company Ltd	Supplies knapsack sprayers, pesticides, herbicides, fumigation sheets, farm implements
Agro –sack Industries	Manufacturers of polypropylene bags for seeds, fertilsers and rice.
Charles Stewart Day Old Chicks Ltd	Distributors of Hyline layers and Ross broilers chicks
Rab Processors Ltd	Growers ' mash, layers marsh, broiler starter and finisher.

THE ROLES OF AGRO- BASED INDUSTRIES IN SUPPORTING THE GROWING POPUPATION

A. Equip farmers with inputs like fertilizers, livestock feeds, improved seeds and breeds, and farm machinery that help to increased agricultural production thereby increasing income to farmers and food supply for the population.

B. processing raw materials into finished product by adding value for home consumption and easy export to earn foreign reserves.

C. Provided a market for agricultural products thereby enabling farmers to convert their agricultural commodities into cash that is used to meet their needs as well as expand their farming activities.

D. Feeding and clothing the nation as food and textiles are distributed to feed and clothe the whole population.

E. Providing employment to people who receive income to support their families.

F. Provide revenue to government in form of tax to improve the delivery of social services, such as health, education and security to the people.

G. Ensure food security by ensuring that everyone who can afford should access it anywhere in the country.

GENDER AND AGRICULTURAL DEVELOPMENT

WAYS OF INCREASING PARTICIPATION OF WOMEN IN DECISION MAKING IN AGRICULTURE

a. **SOCIAL EMPOWERMENT**

Equal opportunities in education to both the boy and a girl participation as education gives women confidence that what men can do they too can do thereby strengthening their position in decision making.

b. **POLITICAL EMPOWERMENT**

Providing more opportunities for women to be adequately represented in political positions like leadership in farm clubs for their voices to be heard.

c. **ECONOMIC EMPOWERMENT**

Review the law to change the economic position of women so that women should own land and property as well as income without an interference from husband, brother or other relatives.

d. **CULTURAL EMPOWERMENT**

Enlighten the population on the immense contribution women make in agricultural development and view them as partners and not subordinates and inferiors against our culture that fails to recognize the value of female 's farmer's contribution to family farm and home.

e. **ROLE MODELLING**

Produce role models by developing documentaries for the print and electronic media for the would-be upcoming women farmers to emulate.

HIV AND AIDS AND AGRICULTURAL DEVELOPMENT

IMPACT OF HIV/AIDS ON AGRICULTURAL DEVELOPMENT

a. **Reduce the labour force as HIV/AIDS weaken the farm workers energy reducing their ability to do meaningful work and affecting their profitability of agricultural production.**
b. **Wastage of valuable time for farming as sick farmers stay at home or bedridden at hospital a double tragedy as the guardian is removed from agricultural activities resulting in low agricultural production.**
c. **Low standards of living the infected individuals and relatives suffer hopelessness hence lacking motivation to invest in agriculture thereby reducing agricultural production.**
d. **Wastage of valuable resources by individual families and government spent on nutrition, purchase of expensive drugs to keep the disease at bay, depleting family capital and hampering agricultural production as resources for inputs are exhausted.**
e. **Killing the productive farmers in the population of ages 15 t0 49 eliminating people to cultivate and boost agricultural production.**
f.