UNDERSTANDING AGRICULTURE

MSCE SYLLABUS-BASED
FORM 3&4

S.N.D. Sakhuta.

2011 Production

Acknowledgement

I thank God almighty for giving me grace for this book to be written.

Special thanks also go to Mr. S. Chiwala who performed much of the technical Support.

Mr Likeke and Mr Mzumara also are acknowledged for their Material support.

I appreciate the advisory role that Mr M. Kamangira played for the organization of the contents in this book

My wife deserves a part at the back for her emotional support and encouragement when this book was being written.

Abstract.

This book is very important to Malawian Secondary School Agriculture Students especially at M.S.C.E. Level. It has been written with clear knowledge and understanding of the requirements of M.S.C.E.current syllabus.

A thorough need analysis for secondary agriculture students was carried out to come up with organization of the materials in this book. It tackles all objectives in each topic included at forms three and four.

However this book can also be used as a reference material in other levels as well as other relevant fields

The book can be used as a teacher's guide as well as a student text book

About the Author

Samuel Nathane Dytone Sakhuta *is an experienced Secondary School teacher. He has a Diploma in education* ***(Dip.Ed)*** *obtained from Domasi College of Education and A Bachelor of Science* ***(BSc)*** *Degree obtained from the University of Malawi. He teaches Geography, Agriculture, Home Economics, Life Skills and Social Studies. His aspiration is to improve education standard in Malawi and further his education to become an effective and reliable citizen to the development of our nation*

Contact Address

Private Bag 3,

Madisi, Malawi.

ssakhuta@gmail.co.

Tell: 01 907 958

Cell: 0999 561 021

I can do all things through Jesus who strengthens me.

Philippians 4 verse13

Table of Contents

UNIT 1 THE AGRICULTURAL ENVIRONMENT

Agricultural environment is everything that influences the production of crops and animals.

1. Physical environment
   Example: Soil, water, sunlight, air

2. Social environment
   Example: population

SOIL

Soil is the top loose layer covering the earth's surface

Components of soil

- Water
- Air
- Living things
- Rock particles are divided into two namely
  1. Insoluble : example sand ,silt, clay
  2. Soluble : example mineral salts

Importance of soil

- Anchorage
- Shelter for useful organisms
- Storage of water for plants

Soil Properties

- Soil properties refers to different characteristics of different soils examples are
  - Salinity
  - Texture
  - Structure
  - Colour
  - Depth
  - Consistency
  - PH
  - Mineral composition
  - Cation exchange capacity
  - Porosity

The above characteristics can be grouped into two namely

i. Physical properties
ii. Chemical properties

PHYSICAL	CHEMICAL
Structure,Consistency	Mineral composition
Colour	Cation exchange capacity
Depth	Salinity
Texture	Soil PH
Porosity	

TOPIC 1: PHYSICAL PROPERTIES OF SOIL

1. Soil Texture

- Soil texture refers to coarseness(smoothness) or fineness of soil
- This is due to the presence of the three soil particles
- Soil texture can therefore be defined as proportion of the three soil particles in a soil
- Proportion can be interchanged by
- Percentage
- Ratio
- Amount
- Quality

a. Sand

- Is one of the rock particles that up soil in terms of size. Sand is the largest of the three
- Sand particle range from 0.02cm to 2mm in diameter
- Sand particles can also be characterized by
    i. Not sticking to finger
    ii. It produces cracking noise when rubbed
    iii. Feel very rough when rubbed.

b. Clay

- This is the smallest of the three. Clay particles are smaller than 0.002m in diameter
- Clay particles are very stick either when wet or dry when rubbed, they are very smooth if dry.
- Rubbing wet clay particles them becomes shiny(polishing)

c. Silt

- Silt is the medium of the three
- It partially sticks either when wet or dry
- When rubbed it is partially smooth nor cracking noise
- It is partially shiny

Determination of soil texture

- There are many ways in which the amount of sand, silt and clay in a soil can be found/ estimated
- Among the many ways are
    i. Feel method
    ii. Sieving method
    iii. Sedimentation method

i. Feel Method

- This is one of the mechanical methods of estimating the amount of sand, silt and in a soil.
- Collect a soil sample approximately about 15-20g.
- Put the collected soil sample between your thumb and the fore finger and rub it
- If the soil sample is very rough this means that the soil has plenty of sand
- If the soil is very fine, the soil has abundant clay.
- Add a few drops of water to the soil sample and rub it.
- If the soil sample is very sticky soil is made up of clay particles
- If soil sample partially sticks is made up of silt.
- If soil sample does not stick, soil is made up of sand.
- Try to mould a ball
- If you make a ball but breaking in the course of rounding it the soil has plenty of silt.
- If you fail to make a ball the soil is made up of sand

- Try to make a rod
- If you succeed to make a without breaking the soil is made up of clay
- If you succeed to make up a rod but only a short one the soil is made up of silt.
- With sand you cannot make any rod
- The method is also known as ***bing method***

ii. Sieving Method

- Sieving is also known as sifting
- Using this method a soil sample of about 15-209 is collected crush loose the soil sample if it is in clod form
- Also have a set of sieves about four (4) of them with varying size of apertures. Example: 2mm/0.2mm, 0.02mm and 0.00mm.
- Join all the sieves and at the base of the forth sieve, put a collecting container.
- Then put the soil sample in the top sieved and begin shaking the sieves gently
- Soil particles will automatically be separated as you will be sifting smaller particles will be collected in the container, while silt particles will remain in the sieve 4.
- Fine and course sand will remain in sieve 3 respective19.
- In sieve 1 gravel which is greater than 2mm in diameter will be collected
- Weigh the collected particles on a balance to get their masses. Fine sand and course sand can be mixed together before weighing for instance you may find the masses of sand, silt and clay as follows
    i. Sand 13g
    ii. Silt 5g
    iii. Clay 2g
- Then express these masses as percentage of total soil sample collected. For example:

$$\text{Sand: } \frac{13g}{20g} \times 100\% = 65\ \%$$

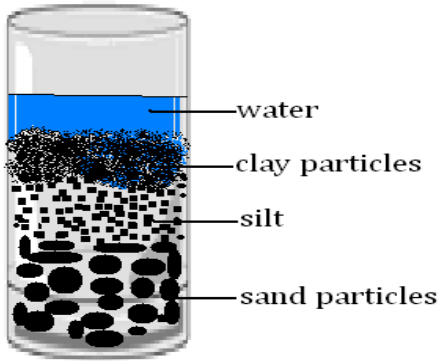
- This means that the soil where the sample has been collected certain 65% sand particles following the same argument may be found/calculated that

    Silt is 25 %

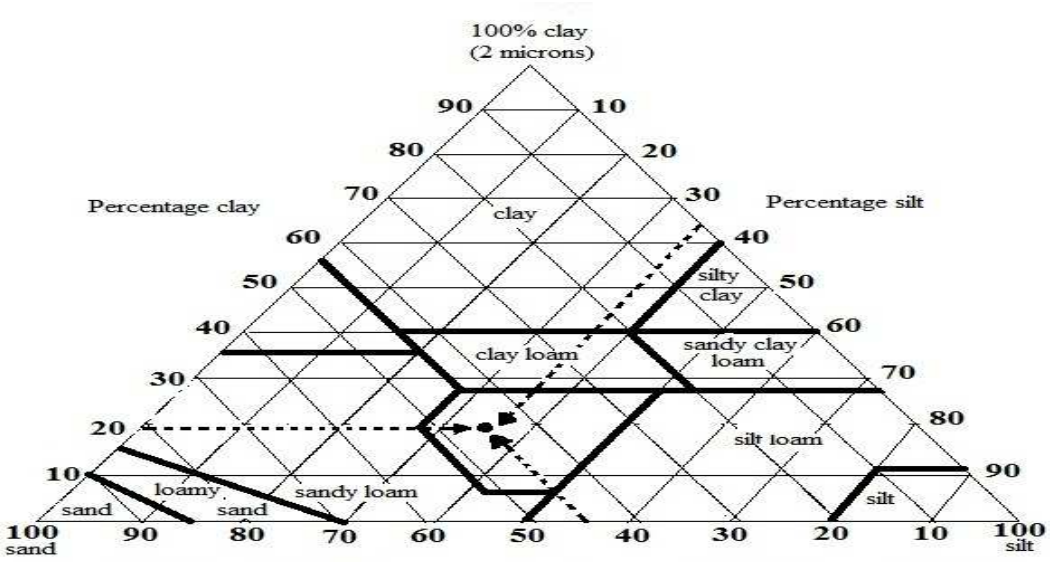
    Clay is 10 %

iii. Sedimentation method

- Using this method different textual classes are determined.
- Soil is put in a transparent bottle, little water is added and it is shaken vigorously.
- The contents are allowed to settle.
- It will be observed that soil texture with very course structure will settle at the bottom while the soil texture with finest structure will settle on top of the layers.



Sedimentation method of determing soil texture



The Soil Triangle - the dot represents a loam soil with 45% sand, 35% silt, and 20% clay content

Effect of soil texture on crop production

- Water retention (holding)
- Water loss (Drainage)
- Aeration
- Mineral retention
- Root penetration
- Resistance to erosion
- Workability

Easiness/difficult soil structure

- Arrangement of primary soil particles to form up aggregates (collection) for collection to be formed cementing agents must be present to bind particles together. For example of cementing agents clay particles organic matter (manure) Lime

2. Soil structure

Types of soil structure

- There are many ways in which soil particles are arranged
- The arrangement of these particles could be determined by the reasons types of SHAPE of these particles.
- For these reasons types of soil structure are quite often looked at as different shapes of soil particles. These shapes include:
    i. Platy
    ii. Blocky
    iii. Prismatic
    iv. Spheroid

All soil in Malawi will exist as either granular or crumb structure

a. Granular

- I n this structure soil particle exist as single or individual grains.

- They are loosely packed without being cemented

b. **Crumb**

- Soil particles are always cemented together and therefore exist as collections. For example- clay soils.

i. Platy Structures

- Soil particles are flat lying on horizons axis.
- They have a plate like shape.
- These produce small voids.

ii. Blocky Structure

- Soil particles have many sides they appear as block/cubes.

iii. Prismatic Structure

- Particles have prism shapes when packed together they leave large voids.

iv. Spheroidal Structure

- Particles are arranged around a central point. They form up a structure like a sphere particles under this arrangement may either be granular or crumb.

Importance

- Water holding capacity is affected by how soil particles are arranged
- Drainage (water loss) is affected by the structure.
- Affect soil aeration.
- Affect microbial activities.
- Affect soil workability.

Improving or modifying soil structure

- Apply organic matter or (manure)
  - Manure are organic matter provide the cementing agents to help their aggregate soil particles.
- Cultivate the soil at the right (correct) moisture content.
- Protect the soil against rain which splashes the particles.
- Proper use of farm machinery heavy machinery e.g. tractor and drawn implements must not be frequently used to avoid soil composition.
- Practice crop rotation (i.e. changing crops following a sequence of on order.

3. Soil Colour

Factors affecting soil colour

a. Aeration
b. Drainage
c. Parent rock material

- It also indicates the presence and amount of organic matter in the soil.
- The types of parent material in the soil

4. Soil Aeration

- Soils which are poorly drained or water lodged looks greyish.

- Such soils are poorly aerated soils that are well aerated are usually brown, red, yellow in colour.

5. Presence of Organic Matter

- Soil colour is also influenced by organic matter
- Soil containing a lot organic matter or humus is dark or black in colour.
- Soil containing less humus or organic matter looks reddish or red, brown in colour.

6. Parent Material

- Colour also indicates the type of parent material in the soil.
- A soil which contains a lot of Iron Oxide is usually red, yellow or brown.
- A soil containing mica has glittering appearance
- A soil rich in Silica (quartz) tends to be whitish or greyish white in colour.
- Soil colour also shows that the extent to which the minerals in soils have undergone weathering.
- This colour is useful way of classifying soils.

5. Soil Temperature

- Soil temperature affects
    i. Soil formation
    ii. Evapotranspiration
    iii. Maturation and dying of crops
    iv. Seed germination
    v. Root growth
    vi. Chemical reaction in the soil
    vii. Activities of soil micro-organisms. i.e. the optimum microbial activities happens when temperature are 25^{o}C and 40^{o}C.
- If the temperatures are below 40^{o}C the decomposition tends to decrease.

Factors that influence soil temperature

These include

i. Soil colour
ii. Vegetation
iii. The shape of the land.

i. Soil Colour

- Dark soil tends to absorb more heat (energy) from the sun than soils which are light colour.

ii. Vegetation

- Soil temperature does not fluctuate as much as under vegetative cover as it does when the soil worms up easily during the day and cools off more rapidly at night.
- A garden which slopes towards the north.
- If it is in the southern hemisphere it (is) heated more than land which faces south.

How soil temperature can be altered or modified

i. By the practice of mulching crops
- Mulching is defined as the spreading of leaves dry glass or other vegetative matter on the soil.

ii. By planting vegetative cover.
iii. By irrigating crops and draining the soil.

7. Soil Consistency

- Soil consistency refers to the state of soil under different moisture condition.
- When the soil is dry.
- It does not break down easily
- Thus it is either hard or very hard
- Soils have got different moisture levels at different times.
- At times soils may have law moisture levels (dry soils)
- And at other times soils are wet when dry- some are hard or very hard others are soft when wet. Some soils are firm (don't break easily) others are FRIABLE (easily broken) loose with little pressure.
- Yet others are plastic (i.e they are sticky)
- Soil consistency affects workability of the soil upon either are so hard that working on the simply breaks the particles into very fine particles (dust) which is easily blown away by wind.
- When wet clay soils are very plastic so much that working on them puddles (creates mud) on the soil.
- To improve workability of the soil, soil need to be worked upon when they have the right moisture.

8. Soil Depth

- Soil depth is related to soil profile
- Soil profile is the vertical arrangement of the soil.
- Top soil is mostly used for crop production. Because
    i. It contains water
    ii. it contains organic matter
    iii. it contains nutrients
    iv. has good temperature
    v. it contains a lot of air
    vi. it contains micro-organisms (living things)

The depth of zone A (topsoil) varies from one soil to another depending on:

i. **Slope**

- On steep slopes, there is a lot of erosion taking place reducing the soil depth.
- On flat land, soil depth increases due to sedimentation.

ii. Parent rock material.

- Soft rocks break down easily resulting into a lot of soil being formed within a short time and therefore mature quickly.
- Hard rocks on the other hand badly break resulting into small amount of soil formed hence shallow soil.

Importance of soil depth

i. Effects root development

ii. Effects nutrients holding capacity
iii. Effects of amount of water
iv. Effects amount of air.

9. Porosity

- Porosity is the state of being porous of on object.
  - porous means having pore spaces of air spaces
  - different soils have different porosities
  - clay soils have numerous but very small space percentage polarity is bigger that sandy soil which have large but very few spaces related to soil porosity is the bulk density.

$$BD = \frac{W}{V}$$

BD is BULK DENSITY

W is Weight of oven dry soil

V is Volume of oven dry soil

% solid space

$$\frac{\text{Bulk density}}{\text{Particle density}} \times 100$$

% pore space + % solid space = 100

$$\% \text{ porosity} = 100 - \frac{BD}{PD} \times 100$$

PD is particle density.

TOPIC 2: CHEMICAL PROPERTIES OF SOIL

Apart from the physical aspect soil has chemical component that need to be understood in order to improve crop production. This include

- Soil PH
- Mineral composition
- Cation exchange capacity
- Salinity

A. Soil PH

- PH stands for potential hydrogen
- By definition soil PH means the acidity of alkalinity of a soil.
- This is the condition of a soil where it may be acidic or alkaline.
- Soil PH is determined by two types of ions namely
  i. The hydrogen ions H^+
  ii. The hydro x gil ion OH^-

If $[H^+]$ }$[OH^-]$ soil is acidic

If $[H^+]$ { $[OH^-]$ soil is alkaline

If $[H^+]$ = $[OH^-]$ soil is neutral

Measuring Soil PH

Can be measured by using

i. Litmus paper
ii. universal indicator
iii. PH meter

i. Litmus Paper

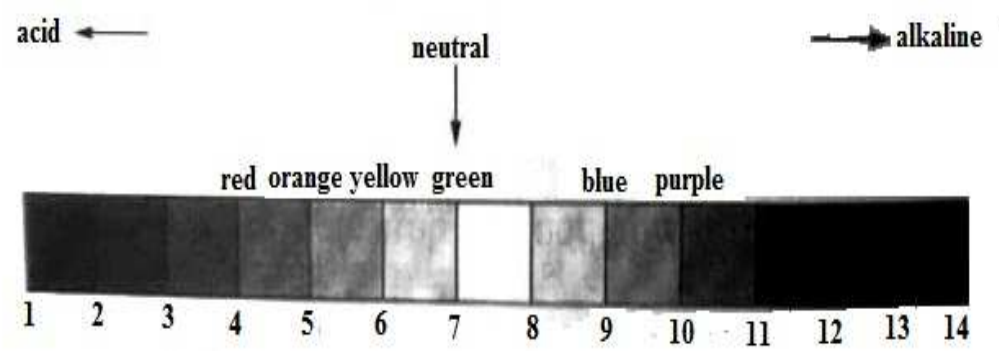
- Litmus paper is an indicator paper which turns red in acidic conditions or blue in alkaline
- Also remember that there are two types of litmus paper the Red and Blue litmus paper.
- The major weakness of litmus paper is that it only tells you whether soil is acidic or basic but not how strong the acidity or Basicity of the soil is.

ii. Universal Indicator

- Universal indicator as indicator tells us more about soil conditions unlike the litmus paper
- Using universal indicator different colours are obtained ranging from pink, Red to green and violet. At each colour obtained a digit is assigned to it.
- Both the digit and the colours represent the PH scale
- The PH scale therefore ranges from 1→ 14 where
  1 represents the strongest Acid
  14 represent the strongest Alkaline
  7 represent the neutral conditions
  6 represent the weakest Acid
  8 represents weaken Alkaline.
- Please take **note** that a PH declines acidity increases, and as PH increases, acidity reduces.

iii. PH Meter

- This is an instrument that accurately measure soil PH. It has electrodes which are dipped into the soil solution. It also has a pointer which points over a scale.
- Once the electrodes have been dipped into soil solution the pointer moves and the reading pointed is the PH for the soil.



The pH Scale

Factors affecting Soil PH

- There are many factors that affect soil PH which includes
  i. Leaching
  ii. use of fertilizer
  iii. microbial activities
  iv. weathering of parent material
  v. nutrient uptake
  vi. drainage
  vii. type of vegetation

i. Leaching

- During continuous heavy rainfall plant elements such as calcium (Ca^{++}) sodium (Na^{+}) magnesium (mg^{++}) and potassium (K^{+}) are leached down the soul profile
- The elements are then replaced in turn increase soil acidity

ii. The use of acid farming fertilizer

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

iii. Microbial activity

- Microbial activity increase soil PH as hydrogen Ions are released during the decomposition of organic matter.
- Again the CO_2 which is produced by microbes dissolves in water and forms carbonic acids, which in turn increase soil acidity.

iv. Weathering of parent material

- Parent material contains different mineral elements which, when weathered affect soil PH.
- For instance, soil PH is increased if the parent material contains sulphur.
- This is through the formation of sulphuric acid.

- Soil formed from limestone have a high PH (or in another word, they have basic PH)
- The weathering of parent material may also result in the accumulation of such ions as K^+ , Na^+ ,Ca^{++} and mg^{++}.
- These tend to increase soil PH

v. Nutrient up take by plants

- Plants absorb nutrients from soil to manufacture their own food.
- When the crops are harvested the nutrients absorbed by plants are also lost from the soil.
- These lost nutrients tend to be replaced by hydrogen , which lower the soils acidity the nutrients that are absorbed by plants include: Potassium (K^+) sodium (Na^+) calcium (Ca^{2+}) phosphorus (p^{-3}) Nitrogen (N^{-3})
- For example if Na^+ is used up by plants the Na^+ tend to be replaced by H^+ (hydrogen ions)

vi. Types of vegetation

- The type of vegetation growing in a soil affects the soil PH in several ways.
- For instance, the decomposition of organic matter influences soil PH through the release of nutrients.
- Above all, the type of protection to the soil against rainfall impact and soil erosion. It is known that soils in forest tend to have a lower PH than those in grasslands, where loss of nutrients through leaching is reduced.

Importance of soil PH in crop production

i. Soil PH affect or determine where some crops should be grown depending on the level of PH because some crops do well under acidic conditions and others do well under alkaline conditions. Examples of crops that do well under:
   - *Acidic Condition* include tea, pineapples, Berries cow peas, water melons
   - *Basic Conditions* include beans, peas, sugar beans, groundnuts, cabbage and sunflowers.
   - *Moderate PH (PH + 6 and PH 7)* include maize, wheat and sorghum.
   - Millet, rice, cotton, water melons and cowpeas do well when the PH is between 5 and 6.5.

ii. Soil PH affects the availability of soil nutrients needed for plants growth.

- Elements such as zinc (zn) iron (fe) manganese (mn) copper (Co) and Cobalt (co) become less available (in soil with a PH above 5.5
- However nitrogen (N) potassium (K) and sulphur(S) become readily available when the PH is above 5.5
- Calcium (Ca) and magnesium (mg) become available when the soil PH is between 6 and 8.5
- Molybdenum, an important micro- nutrient become available is soil with a PH between 5.5 and 9.
- Phosphorus (p) is leached up in soil of a PH below 6
- Most plants nutrients tend to be available when the soil PH is between 6 and 7

iii. Soil PH also affects microbial activities

- Microbes such as bacteria tend to be active when the PH is 5.5
- Fungi however tolerate a wide range of soil PH
- Bacteria and Fungi are important for decomposition of organic matter.
- Nitrification and nitrogen fixation by bacteria takes place vigorously of PH 5.5
- On the whole beneficial micro-organisms tend to function well in soils between PH 5.5 and 7.

Modification or improvements of soil ph

- Acidic soils can be corrected by adding lime or fertilizers containing calcium ammonium nitrate
- Lime tends to neutralize soil acidity
- Basic soils can be corrected by adding acid forming fertilizers such as sulphur or phosphate fertilizer

Factors affecting the chemical properties of soil

1. The composition of the soil itself
   - The inorganic (mineral) and organic constituents of the soil to affect the ability of the soil to retain ad release plants nutrients
2. Soil structure and texture
   - These affect the nutrients status.

B. C E C (Cation Exchange Capacity)

- Cation exchange capacity by definition means an ability of a soil to loose its cations and replace them with similar particles (exchange at a given PH per unit weight of soil.

Importance of cation exchange capacity

i. Liming

- Liming is the addition of calcium compound to soil to increase its PH.
- Liming obeys the principle of cation exchange capacity. A soil where lime has added loses some of its H^+ and replaces them with Ca^{++}.
- Availability and release of plant elements is vital to plant growth

ii. Application of manure

- Manure is a pool of different nutrients
- The different minerals contained in manure helps to keep constant (maintain) soil conditions
- Farmers are advised to modify their soil through applying organic matter that helps in the formation of soil aggregates which act like ware houses for plant nutrients
  The plant nutrients found in organic matter include NH_4, Ca^{++} , K^+ ,Mg^{++}

NOTE: This is the condition of the soil in association with accumulation of soluble salts

e.g. Nitrate (NO_3^+) , Solphates (SO_4^+), Bicarbonates of chlorides ($C\ell$)

iii. Application of fertilizers

- We apply fertilizer in the soil to improve/ maintain modify soil PH.
- This can work/done if the cation exchange capacity has done for example if CAN is applied it needs hydrogen to gain calcium ions and calcium gain hydrogen to which is similar cation.
- When this has not done nothing can happen.

C. Salinity of Soil

- A saline soil is the one which has high concentration of soluble salts (alkaline salts)

- These soluble salts such as mg, Ca, Na etc are combined with other elements such as chlorine (Cℓ) carbonate (CO_3) Nitrate (NO_3) to make iodine compound.

Causes of Soil Salinity

i. **Fertilizer application**
- The continuous application of soluble salt containing fertilizer results into build up of such soluble salts in the soil hence soil salinity.

ii. Poor drainage
- Poor soil drainage has a superficial layer of water above them where soluble salts have dissolved the soil leading soil salinity.

iii. Irrigation
- Irrigating crops using poor quality (salty) water increases the concentration of soluble onto the soil.

iv. Parent rock material
- An underlying rock material containing soluble salts will exude the soluble into soil

v. Low rainfall but high evaporation
- Low rainfall areas usually associated with high evaporation.
- The little water that dissolves soluble salts quality evaporates leaving salt crystals on the top soil.

Managing saline soils

- Irrigating crops by flooding
- Encouraging drainage to have place by constructing water ways
- Applying gypsum which helps to convert (insoluble) carbonate salts in sulphate to easily leach.
- Preventing or reducing evaporation e.g. mulching planting vegetative cover
- Growing salt tolerant crops e.g. cotton and Spanish.

Sodic Soils

- These are soils which high amount of sodium places like Chikhwawa, Kasungu and Mzimba district in Malawi have sodic soils
- When salts accumulate on the surface of soil bringing a white colour surface and in some areas goats and cattle like such surface
- Sodic soils are toxic to plants

Factors that cause soil to become saline

- Irrigating virgin land with salty water
- Application of fertilizers which may lead to the build up of salts in the soil
- Release of salts by parent material
- Low rainfall and high evaporation salts accumulate on and below the soil surface due to capillary action or limited leaching

- Poor drainage of the soil which lead to the build-up of salt

Effects of salt accumulation

- It affects seed germination and plant growth through
- Affects availability of water because of high osmotic concentration of the soil solution
- There is high level of exchangeable sodium (Na) which affects physical and chemical properties of soil.

NOTE

Excess Na disperses day resulting breaking soil aggregates which reduces permeability of water and air.

High osmotic pressure reduces the ability of roots to suck in water (crops dry up even when water is available in the soil)

Salts may be poisonous to some crops between different crops prefer different levels of salt concentration in the soil.

LOW SALT TOLERANCE	MEDIUM	HIGH
Green beans	Rice, sorghum, maize	Cotton, spinach, rape
Field beans	Wheat, tomatoes, oats	Barley, sugar beet
Apples, pears, Apricots		

How can saline soils be managed

- Irrigating soil by flooding using salt free water
- drainage
- application of gypsum which helps to convert insoluble carbonate salts into soluble sulphate which can easily be reached by irrigation
- mulching the soil to reduce evaporation
- growing salts tolerant crops

Factors affecting chemical properties of soil

- Composition of the soil
- Structure and texture
- Forming particles
- Soil acidity
- Leaching soil erosion
- Use of chemical fertilizer

General ways of maintaining or improving chemical properties of soil

- Liming to increase soil PH

- Applying organic matter to improve soil structure
- Applying fertilizer correctly
- Practicing crop rotation
- Practicing biological soil and water conservation methods
- Controlling bush fires
- Mulching crops to reduce rain drops impacts and erosion
- Practice mixed cropping
- Irrigating land by flooding to flash excess salts

TOPIC 3: SOIL DEGRADATION

Soil degradation refers to a loss in the value and quality of the soil.

CAUSES

- Soil degradation is caused by:
  a) Soil erosion
  b) Loss of soil fertility

The rate of soil erosion is accelerated through human activities such as;

- Deforestation
- Continuous farming on the same piece of land without rotating
- Setting of un controlled bush fires which leaves the ground bare and thus accelerate erosion by water and wind
- Cultivating along the steep slopes or stream banks
- Constructing ridges along the slope
- Use of heavy machines which destroys the soil structure
- Cultivating the soil when it is too wet or too dry
- Overgrazing due to overstocking which destroys vegetative cover
- High population growth creates great pressure on the available land sources as such people are forced to cultivate marginal lands.

What causes soil erosion?

- Soil erosion occurs because of the effect of water, wind and machines.
- When the soil is loose, the rainfall carries away the loosened particles and deposit them elsewhere
- Unprotected soil becomes dried by the sun and, the wind blows it away especially during the dry season
- Physically machines break the soil particles into smaller particles and these later are carried away by rainwater or brown off by wind
- Excessive use of fertilizers and pesticides cause chemical degradation
- Biological degradation is as a result of frequent movement of people, animals and microbes as they move along the tracks
- The quality of soil is also affected by salt accumulation that occurs due to poor drainage and low rainfall
- Loss of soil fertility is due to the loss of top soil which contains plant nutrients through water and wind erosion

Effects of soil degradation

- Loss of fertile top soils results into the reduction of crop yield.
- Increased water run-off and reduced infiltration.
- Silting of water reservoirs i.e. Lakes, dams, rivers due to sedimentation.
- Pollution of water resources.
- Drying up of rivers and this causes water scarcity.
- Low ground water table due increased run-off and reduced rate of infiltration.
- Loss of arable land due to gullies that are formed.
- Loss of grazing land.

Control of soil degradation

- Soil degradation can be controlled by the following Biological and Physical conservation measures.

i. Biological Conservation Measures

- Planting trees and grasses to maintain soil cover
- Planting close growing cover crops such as groundnuts and sweet potatoes
- Practice strip cropping to reduce run-off
- Practicing agro forestry
- Practicing crop rotation
- Controlling bush fires
- Reducing the stocking rate to prevent overgrazing
- Practicing rotational grazing
- Practicing family planning to control high population growth hence reducing pressure exerted on land and soil resources

ii. Physical Conservation Measures of Controlling Soil Degradation

- This method is aimed at reducing the speed of run-off and allowing the water to sock into the soil.
- Such measures include:
  - Constructing storm water drains which divert water from up land into a natural or artificial water way.
  - Constructing tie or box ridges which help to hold water in furrows, allowing water to soak into the soil.
  - Constructing contour (Ridges across the slope)

UNIT 2: CROP PRODUCTION

TOPIC 1: THE PLANT PARTS AND THEIR FUNCTIONS

Plants are categorized in many ways

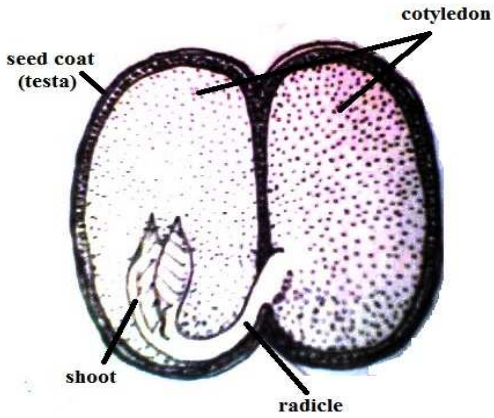
- Legumes and cereals
- flowering and non-flowering plants
- dicotyledonous and monocotyledonous plants

1. Legumes

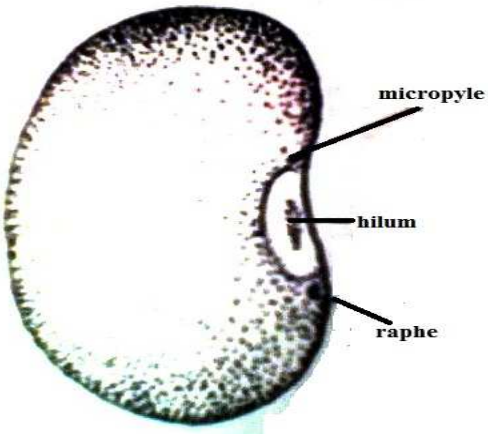
a. SEED

An external and internal parts of a bean seed

a. **b.**



Internal Structure of a Bean Seed



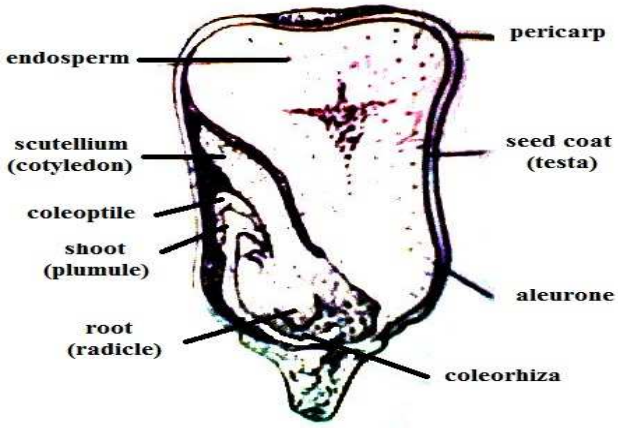
External Structure of a Bean Seed

Functions of parts of legumes seed

- **Funicle** : This is a short stalk which attaches the bean seed to the inside of the pod.
  : This is also passage of food from the plants to the developing seed
- **Hilum** : It is the black scar where the funicle attached
- **Testa** : This is the seed coat that protects the seed from mechanical injury and entry of pathogen
- **Cotyledons**: These are soft nutrients for the developing embryo
- **Radicle** **:** The part of the embryo that develops into young shot
- **Plumule** : The part of the seed that develops into a young shot
- **Hypocotyl** : The middle part of the embryonic structure which develops into the stem.

2. Cereals

- The maize grain is not a true seed but a fruit



Internal Structure of a Maize Grain

Functions of parts of cereal seed

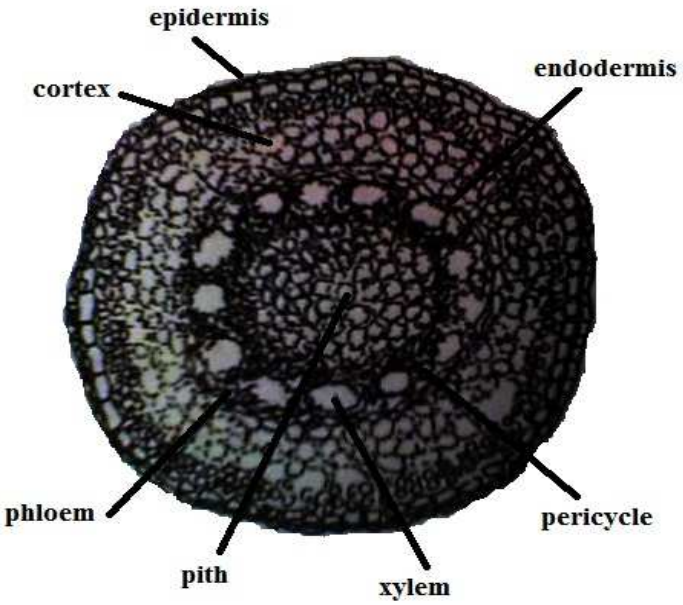
- **Fused pericarp and testa**
- This is a fruit wall and seed coat
- It protects the delicate internal part of the grain in the brain left on after
- **Sick Scur**
  - A depression showing the parts of attachment to the silk each grain in attached to a silk
- **Endosperm**
- The floury part of the grain
- It supplies food for energy for the germination and development of the embryo
- Grass family seeds are called endosperm seeds.
- **Radicle**
  - Develops into sperm
- **Plumule**
  - Develops into leaves
- **Coleorhiza**
  - This form a protection sheath enclosing the roots
- **Coleoptile**
- A protective sheath surrounding the plumule in the grain
- It protects the shoot as it pushes through the soil during germination.
- **Scutellum**
  - This is a flattered fleshy shield-shaped which forms the outer part of the embryo separated it from the endosperm
- This is regarded as a cotyledon of the cereal grain (monocotyledons)

Plants and their function

- Normally all plants have roots, stem and flowers.
- Typical flowering plants like legumes and cereals have a root system and the shoot system

3. ROOT SYSTEM

- **Tap root system**
  - The part below the ground which tap root and fibrous root.



Cross section of the internal structure of a root

- Tap root system has a clearly identifiable main root and lateral roots e.g. tobacco, tomatoes, cotton, cabbage and legumes.

- **Fibrous root system**
- This does not have the root. All root grow from the base of the stem.
- All grasses (cereals) are under this type of root system.

Functions of the parts of the root

i. **Root Cap**
   - The layers of cells at the tip of the root

ii. **Apical Meristerm**
   - This is the growing part of the root which gives rise to all roots which gives rise to all roots

iii. **The Epidermis**
   - The outer layer of which is protective coat for the root

iv. **Root Hair**
   - Very small hair like structure. They are elongation of epidermis cells
   - They absorb water and minerals from the soil.

v. **The Cortex**
   - Thus the group of cells for food storage

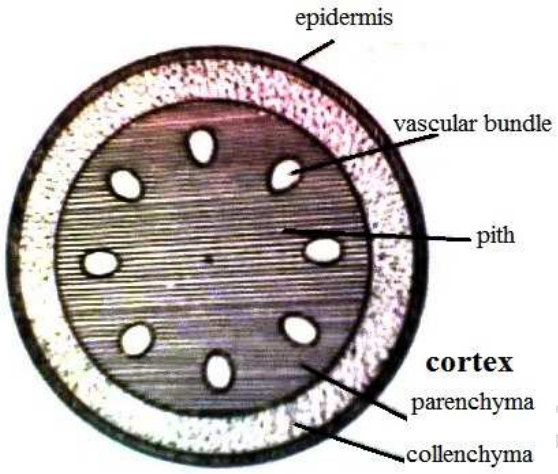
vi. **The Endosperm**
   - This is the layer of cells separating the cortex and vascular bundles.
   - Vascular bundles consist of phloem and xylem phloem.
   - These are cells which transport products of photosynthesis in food manufactured in the leaves for respiration and storage xylem.
   - Are cells or tubes which transport mineral salts and water by not hair upward.

General function of roots

i. To anchor plants
ii. To absorb mineral salts and water

iii. To store food
iv. A stem has nodes and internodes
v. Buds are formed at the nodes
vi. The space between two successive nodes is called an internode.

3. STEMS



Internal structure of a stem

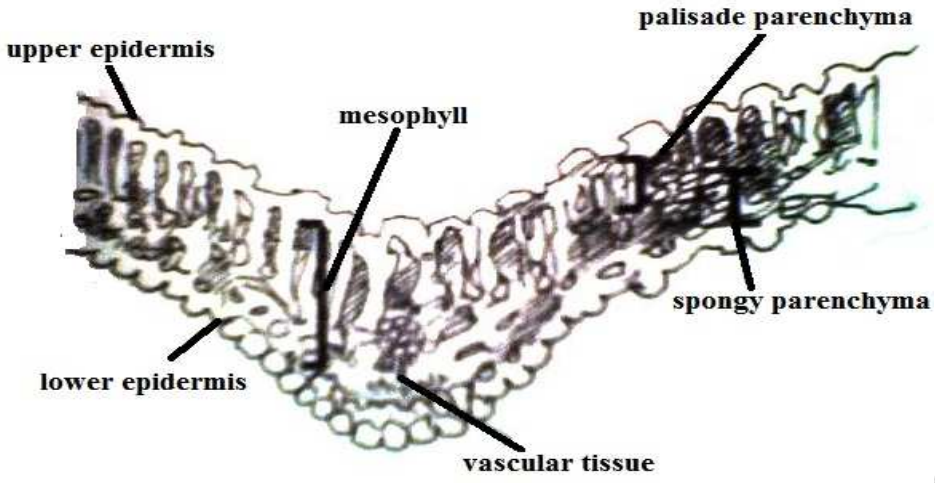
Function of stems

i. They conduct water, food and mineral salts from the roots through the xylem
ii. Transport manufactured food from the phloem to the roots.
iii. To support the branches, leaves and flowers
iv. To display leaves and flower for that they are exposed to sunlight for photosynthesis to display flowers so that can easily see them for pollination.
v. They store food
vi. Manufacturing plant food some young stems have chlorophyll for food manufacturing

4. Leaves

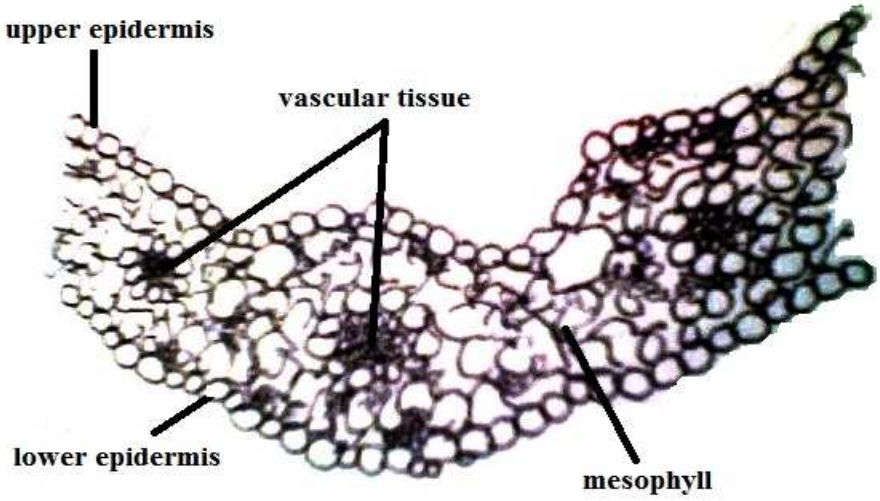
Internal structure of leaves

A.



Cross Section of a legume leaf

B.



Cross section of a cereal leaf

Functions of leaves

i. Photosynthesis
ii. Transpiration
iii. Respiration

- Leaves are organs for gaseous echange.
- An equation for respiration

$$\text{Starch} + O_2 \rightarrow CO_2 + H_2O$$

Functions of the internal parts of a leaf

i. **Upper and lower epidermis**
   - The upper and lower layers on the leaf blade that affect palatability to livestock

ii. **Guard cells**
   - Pairs of special cells in between the upper and lower epidermis which controls the openings into the leaf . More are formed in the lower epidermis.

iii. **Stomata**
   - These are the gates or openings into the leaf found between a pair of guard cells
   - The stomata open when the guard cells are turgid or filled with to allow in CO_2 for photosynthesis but they close during drought to reduce water loss.
   - Guard cells have chloroplasts for carrying out photosynthesis.

iv. **Palisade Cells**
   - Most chloroplast are found in these cells to trap sunlight
   - They are long and closely packed.

v. **Spongy Layer**
   - They are loosely packed.

vi. **Vascular Tissue**
   - The mid-rib and veins contain vascular tubes for transporting manufactured food from the leaves to all parts of the plant and transporting water and mineral salts to the rest of the leaf.

Functions of leaves

- Photosynthesis
- Transportation
- Leaves release excess water through stomata (Respiration)
- The stomata allow the exchange or CO_2 and O_2 between the plant and atmosphere.

TOPIC 2: SEEDS AND PLANTING MATERIALS

- Plant propagation is the multiplication of crops using seeds or vegetative parts.
- There are two ways of propagating crops.

1. Sexual Propagation

- This is the multiplication of crops using seeds. Cereals and legumes can be propagated through this method.

Advantages of sexual propagation

- Seeds are relatively cheap
- Seeds are easy to sow, handle and prepare for planting.
- Seeds are stored easily without initial loss of quality and quantity.
- Seeds can remain viable for a long period.
- Chances of transmitting diseases from parents to off- spring are reduced.
- Easy to improve crop varieties i.e. hybridization.
- Crops that can not be propagated vegetatively can be propagated using seeds

Disadvantages

- It can produce serious variation of new off-springs.
- Juvenile period is long before bearing
- Dormancy is long

2. Asexual Propagation

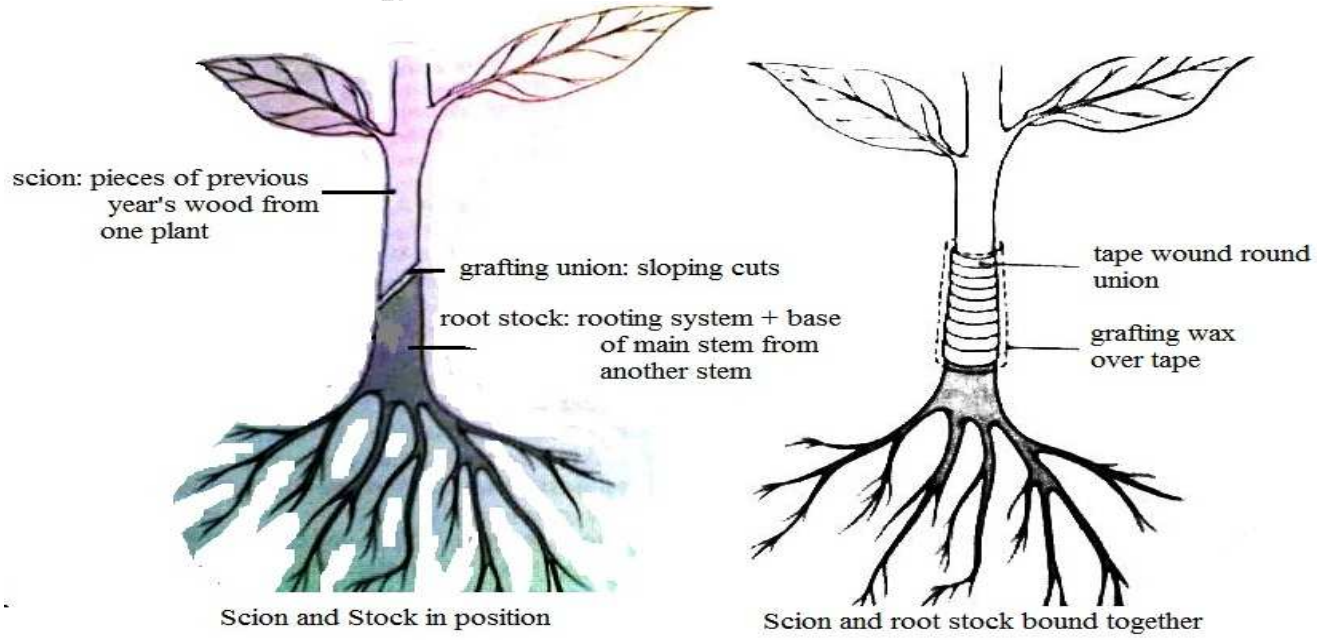
- This is the production of new plants vegetatively without the use of seeds
- This is also called vegetative propagation

Vegetative planting materials and methods

Methods	Materials	Examples
Cuttings	stem cuttings are used piece of plant that base buds at each nodes are used	Sugar cane Napier grass Cassava
Runners	stems that grow along the ground are used the process must have a node from which roots and shoots can develop	Strawberries, sweet potato Star grass
Stem tubers	under ground swollen portion of the plant is used and such apart has buds from which new shoots develop tubes store foods	Irish potato
Suckers	shoots arising from auxiliary but at the base of parent plant they are uprooted and planted else where	Banana Pine apple

Bulbs	these are storage organ of food and H_2O made up closely packed modified flashy leaves buds develop in the exists of the leaves that make up the bulbs	Onion, tulips, garlic
Corms	This is a thickened base of an under ground stem New roots and shoots grow from the bud. The stored food in the corm provide nutrients to the new shoot	Bananas Bamboos
Rhizomes	This is a thick horizontal underground stem. New shoots grow from the buds just like corms.	Bananas Bamboos
Layering	A branch of a fruit is pegged down to the ground so that it can develop roots for a new shoot while still attached to the plant.	Strawberries Guavas
Budding	Buds are used from one plant and attached to the other for it to develop into a new shoot. A T- shaped cut is made where the bud is carefully inserted and bound with twine (string)	
Grafting	This involves joining a scion to a stock so that one plant can have good qualities of two different plants. The two plants must be of the same species and sane thickness .i.e. lemons and oranges The cambium layers must be matched. The cut should be slanting or v-shape and the union be neatly fitted and tapped.	Mangoes Oranges

Grafting of orange fruits



Strawberries propagated through layering

banana Suckers used for propagation

2. Asexual Propagation

- Is the process of propagating plants vegetatively instead of using seeds.
- Parts or the already fully grown plant species is used.
- Examples a sexual propagation could be through the use of stem cuttings, suckers, rhizomes, corms, bulbs and tubers.

Advantages

- It reduces Juvenile period of the plants because vegetatively propagated materials assume the age of their parents.
- Eliminates the problems of dormancy
- Ensures genetic uniformity in crops
- Plants that do not produce viable seeds can only be propagated through this way.
- Vegetatively propagated plants can with stand harsh environmental condition.
- Vegetative materials also act as food reserves to help the shoot to become established
- Vegetative materials are readily available
- More than one type of fruit can be produced on one tree especially in the process of grafting

Disadvantages

- The risk or disease transfer is high.
- It is more difficult to produce variation into crop which makes improvement difficult.
- Vegetative planting materials tend to be bulky
- Some procedures in vegetative propagation require advanced and scientific skills which more farmers can not afford.

- The vegetative materials cannot be kept for along time before it loses value quality.

TOPIC 3: ESSENTIAL PLANT NUTRIENTS

- A plant nutrient is said to be essential when it satisfies the following conditions:
  i. When it is directly involved in metabolic process of a plant
  ii. When its deficiency can cause specific deficiency symptoms in plant
  iii. When the deficiency symptoms can only supplying the plant nutrient. Just like any living organisms, plants need different elements are available to plants they are known as nutrients.
- A plant nutrient therefore is a mineral element needed by a plant to grow and complete its life cycle.
- Some of the nutrients are needed by plants in large amount while others are needed is smaller of trace amount.
- These needed in large amounts are known as macro elements while those needed in smallest amounts are called macro element.
- Plants get most of their essential nutrients from the soil.

Examples of plant nutrients

Macro Elements	**Micro Elements**
Nitrogen	Baron
Calcium	Manganese
Potassium	Molybdenum
Phosphorus	Copper
Magnesium	Zinc
Sulphur	Chlorine
	Iron

NOTE:

- Oxygen is not needed by plants and it gets released through the process of photosynthesis as a by product.
- Carbon is just an element that is needed for the process of photosynthesis and enters the plant through the leaves.

Macro Elements

1. Nitrogen

- Plants absorb nitrogen as nitrate (NU^{-}_{3}) or as (NH^{+}_{4})

Sources of nitrogen

- In organic fertilizer (CAN – 21 % N) and area (46 % N)
- Organic manure such as composite and farm yard manure.
- Fixation by symbiotic Rhizobium bacteria and free living bacteria (nzoto bacteria) through nitrification process.

- Nitrification of the atmospheric nitrogen through lightening.

Function of nitrogen to plants

- responsible for deep colouring matter necessary for photosynthesis
- it is a major component of protein
- it increases the leaf area and vegetative growth in plants
- it regulates the availability and vegetative growth in plants
- it makes plants and their fruits succulent (Important quality in herbs cabbage, lettuce, carrot, melon) increase grain yield by increasing size in both cereals and grain legumes.

How nitrogen gets depleted

- Denitrification – volatilization
- Absorbed by plants and consequent removal of plants through harvest
- Soil erosion
- Leaching where nutrients are taken down beyond root zone

Deficiency signs of nitrogen

- Stunted growth in plants (dwarfism)
- Loss of chlorophyll in leaves and the leaf of plants turn yellowish in colour
- Premature leaf fall

2. Phosphorus

- This is absorbed by plants as hydrated phosphate (H_2PO_4) at low PH value and dehydrate phosphate at high PH value.

Sources of phosphorus

- Inorganic fertilizer such as super phosphate (P_2O_3 = 21 %) double super phosphate and Trisuper phosphate

- Organic matter in the soil crop residues (mineralization)
- Weathering of partities (phosphatic rocks)

Functions

- It increases the development of secondary roots
- It reduces plant lodging by strengthening the cereal straws
- Speeds up plant maturity by stimulating flowers and seed formation
- Increases disease resistance in plants
- It is a component of adenosine in phosphate (ATP) , Adenosine Diphosphate (ADP) and adenosine monophosphate (AMP) which are important elements for
- Photosynthesis
- Metabolic processes
  e.g. carbohydrates, protein and fat metabolism

- It is a component of nucleic acid essential for repro and seed formation.

What causes depletion of phosphorus?

- Plants absorption
- Crop removal
- Fixation through absorption into silicate clays
- Leaching and soil erosion

Deficiency Signs

- Reduced root development
- Leaves have purplish colour
- Low and stunted growth
- Poor branching as there are dormant buds
- Dead spots on leaves and fruits
- Delayed maturity
- Fewer and smaller tubers.

3. Potassium

- Potassium is absorbed by plants in the form of potassium ions (K^+)

Sources

- Inorganic fertilizers such as muriate of potato ($KC\ell$) potassium nitrate
- organic manures and crop residues
- Potash rocks like mica and feldspar.

Function

- strengthens cellulose in cell walls to make stems strong and reduces stem lodging
- facilitates the translocation of sugars from leaves to other plants parts, especially tubers or seeds so that they are well- filled (plump)
- Helps crops to resist diseases such as powdery mildew and root rot.
- Acts as a catalyst diseases to activate enzymes necessary in metabolic process (including nitrogen metabolism, photosynthesis, respiration etc)
- Promotes the growth of meristematic tissue
- Regulates the opening and closing of the stomata by controlling the water content of plant cells (cell turgidity)
- Improves the quality of crops especially fruits and vegetables.

Reasons for depletion from the soil

- Absorption by plants
- Soil erosion
- Leaching
- Absorption (fixation in soil particles of some days)

Deficiency Signs

- Scorched (burnt) leaf margin from tips spreading backwards, beginning with lower leaves
- Weak stalks, resulting in high plant lodging (stalk breakage)
- Small fruits, seeds and tubers (shriveled seeds)
- Small dots appearing on leaves.

4. Culcium

- Calcium is absorbed as calcium ions (Ca^{2+})

Sources

- Inorganic fertilizers such as CAN
- Agricultural lime such as dolamine ($CAMg(CO_3)_2$) calcium carbonate($CaCO_3$) and quickline(cao)

- Weathering of calcium bearing rocks
- Organic manures.

Function

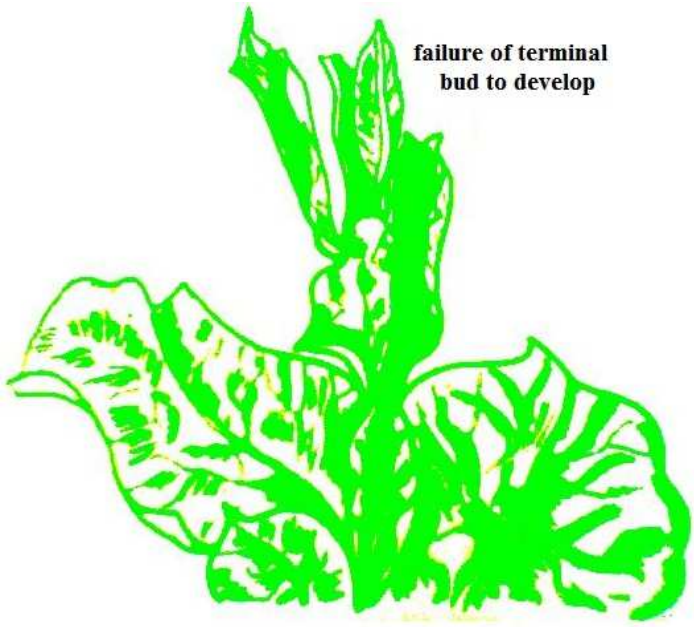
- Necessary for cell division (mitosis) so that elongation can occur in apical tips of the root system and shoot system.
- Raised soil PH which increase the availability of phosphorus and potassium and the multiplication of nitrifying bacteria
- Is a component of cell wall structure
- Is useful in protein synthesis.

Reasons for depletion from the soil

- Absorption by plants
- Erosion
- Leaching

Deficiency Signs

- Terminal buds and root tips fail to grow so that plant stop growing (it remains a dwarf)
- In maize the funnel (new leaves that are rolled up) may fall to unfold (open up) or even emerge
- Terminal buds (growing points) die
- Premature shedding of flowers and buds
- Weak stems



Calcium deficiency in tobacco

5. Magnesium

- Magnesium is absorbed as mg^{2+} ions

Sources

- inorganic fertilizer
- organic manure
- dolomite lime
- weathering of magnesium containing rocks

Function

- is a component of the chlorophyll molecule
- activates enzymes in the metabolism of carbohydrates and nitrogen
- increase the oil content in groundnuts and soya beans

Deficiency Signs

- Intervenal chlorosis on leaves
- Reddish purple colour of the lower leaves in cotton

6. Sulphur

- It is absorbed by plants as sulphate ions
- Sources
- Inorganic fertilizers C.A.N., Ammonium Sulphate, 23:21;0+4s
- Rain water
- Oxidation of Cupper sulphate and Iron Sulphate

- Atmospheric sulphur from industries where coal is burnt to release sulphur dioxide

Functions

- It increases the oil content of oil crops e.g. sunflower, ground nuts and soya beans
- It is a constituent of the three amino acids, namely cystine, cysteine and thiamine.
- It is useful for nodule formation on legume roots for nitrogen fixation
- It is needed for protein synthesis and improves biological value of proteins.

How sulphur is depleted form the soil

- Plant absorption
- Crop removal
- Leaching
- Soil erosion
- Volatisation in the form of hydrogen sulphide gas (H_2S)

Micro Elements

1. Iron

- It is absorbed as ferrous ions and as ferric ions
- Its sources include inorganic fertilizers rich in NPK and chelate as well as organic fertilizers.
- Iron is used by plants for chlorophyll formation and activation of various respiratory enzymes.
- Iron can be lost from the soil through soil erosion, leaching especially in acidic soils and fixation into insoluble forms under high soil PH conditions.
- When iron is deficient in the soil it shows the following signs
  - Intervenal chlorosis of young leaves
  - Young leaves completely turn white
  - Twigs stop growing and branches may die.

2. Boron

- It is absorbed by plants as borax ions
- Its sources include inorganic fertilizers rich in NPK and borax as well as organic fertilizers
- It is essential for cell division in meristematic tissue
- Regulates carbohydrate metabolism
- It is also essential for translocation of sugars.

When boron is deficient in the soil it shows the following signs

- Poor growth and dying of terminal buds
- Shortening of internodes
- Poor grain filling on maize
- Soft or necrotic spots on fruits and tubers

Boron can be depleted from the soil through

- Soil erosion
- Leaching

- Plant absorption

3. Manganese

- It is absorbed as manganese ions (Mn^{2+})

Sources of Manganese

- Manganese sulphate and organic manures

Functions

- It activates enzymes and acts as a catalyst in the formation of chlorophyll.

Methods of depletion from the soil

- Plant absorption
- Crop removal
- Leaching in acidic soils and Soil erosion
- Fixation in alkaline soils

When Manganese is deficient in the soil it shows the following signs

- Mottled Intervenal chlorosis of young leaves
- Intervenal white/ brown specks in some cereals

4. Molybdenum

- It is absorbed as molybdate ions

Sources of Molybdenum

- Inorganic fertilizers rich in NPK fertilizers and organic manures

Functions

- Promotes symbiotic nitrogen fixation in legumes
- Increases nitrogen utilization

Methods of depletion from the soil

- Plant absorption
- Crop removal
- Leaching in alkaline soils in which it is very soluble
- Soil erosion
- Fixation into insoluble forms by ferrous oxides in acidic soils

When Molybdenum is deficient in the soil it shows the following signs

- Whip tail in brassica crops such as cauliflower and broccoli (leaves curl into whip- like tail
- Failure of legumes

Other Micro Elements

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

TOPIC 4: WEEDS AND WEEDING

- A weed is a plant that is undesirable in the field and it is harmful to crops. Weed is of great effect to crop production because they lower yield.

Some examples of weeds

a.Likodza

b. Bononqwe

Classification of Weeds

- Weeds can be classified in many ways

i. Weeds grouped according to leaf shape.

- These include narrow shaped weeds e.g.Panicum maximum (pokopoko) and Couch grass broad shaped weeds e.g. Black jack and Amaranthus (Bononqwe)

ii. Weeds grouped according to their life span

- Annuals-Complete their life cycle in one growing season
- Biennials-They require two growing season to complete their growing season e.g. wild carrot and bull thistle.
- Perennials-These live more than two growing seasons.

iii. Weeds grouped according to feeding habits.

- These include parasitic weeds and non parasitic weeds.
- Parasitic weeds obtain their food from the host where they live.
- Examples of parasitic weeds include
  i. Witch weed: This is an annual parasitic plant. The germinating seedlings develop thread – like roots which penetrate roots of crops to suck sap or plant food. These happen even before the root system of which weed appears above the soil surface. This is the reason why crops like cereals wither and die in a field of which weed.
  ii. Dodder-Plantation trees and vegetables
  iii. Mistletoe –oranges, coffee, rubber, guava trees

iv. **Weeds classified according to preferred feeding habits**

- These include aquatic and non aquatic weeds. Water hyacinth is an example of aquatic weeds. This affects fish farming in ponds.

v. Weeds classified according to seed type.

- This classifies weeds depending on their botanical characteristics i.e. monocotyledonous and dicotyledonous seeds.

Classification of weeds helps the farmer

- To identify weeds in a crop field
- To choose an appropriate method of controlling the particular weed.

Impact of weeds in crop production

- This can also be considered as the importance of weeds because of their destructive power that calls for study, effort and time for controlling them.
  i. Weeds decrease the quality and quantity of crop yield.
  ii. Weeds harbour pests and diseases of crop plants
  iii. Weeds smoother crop plants and as such suppress the growth of plants. e.g. commelina benghalensis-khovani.
  iv. Weeds increase production costs through payment to labours who are employed to clear the weeds.
  v. Weeds reduce the value of agricultural land .This is because weeds are heavy feeders which lower the nutrient status of the soil, other weeds like wild onion taint the colour of milk if eaten by lactating cows while thistle reduce the grazing area and feeding value of pasture.
  vi. Weeds poison livestock e.g. thorn apple, katupe and lantana. These cause severe illness or death in animals.
  vii. Weeds increase the cost of water management e.g. aquatic weeds like water hyacinth interfere with the use of water for irrigation, transportation and fish farming as on the picture below.

Water surface covered with water

Weeds making it difficult for irrigation

Methods of Controlling Weeds

- There are several methods of controlling weeds.

1. **Physical method**
   - This involves uprooting weeds by hands. This becomes successful when all the roots are uprooted.
   - This method is very applicable in ground nuts, rice field ,pastures, pumpkins, melons and sweet potatoes.

Advantages

- It is efficient for removing weeds from the planting stations without any injury to the crop plant.
- Little or no tools are required hence cheap where labour is abundant
- Requires no specific skills
- It is the sure way of killing weeds if the entire root system is removed**.**

Disadvantages

- It is very slow and it is only suitable for a small field.
- It is tiresome
- May not be effective if the weed break up leaving the roots behind. to produce the new shoots
- If it is done in the wet season, it may end up in transplanting the uprooted weeds.
- Allows the weeds enough time to rob the plant of its nutrients and water because pulling waits for the weeds to reach a higher stage of height.

2. **Cultural Method**
   - This involves the use of crop husbandry practices which help the plants to grow fast than the weeds.
   - The crop husbandry practices include; burning, deep tillage, flooding in rice, crop rotation, early planting, correct spacing correct fertilizer application and mulching.

Advantages

- It is easy to use.
- It is cheap.
- It uses normal husbandry practices hence does not require extra effort.

Disadvantages

- The only disadvantage is that it does not control all the weeds

3. **Mechanical Method**
   - This involves the use of farm machinery or farm tools and implements
   - For example
     - Use of slashes just to cut down weeds but not killing
     - Hoeing out weeds- this scrapes off the weeds from the soil and exposes it to the sun's heat.
     - Using sickles and lawn mowers to trim weeds.
     - Using ox-drawn implements like cultivators to dig out weeds and burry them or expose them for drying.

Advantages

- Large plots can be weeded within a short period of time hence faster.
- It reduces drudgery (hard boring) physical method
- It is less tiring than physical methods**.**

Disadvantages

- Implements are expensive to purchase
- May not completely remove all the weeds
- Require extra skills to use the implements
- Some crops may be cut down
- Can not control all the weeds

4. Biological Method

- This uses natural enemies of weeds to check the weeds population.
- Organisms such as animals, insect pests and plant pathogens are used to eat, kill or give them diseases.

Advantages

- It makes use of natural enemies
- Does not require any labour

Disadvantages

- Requires careful attention to maintain balance between pests and weeds.
- Can not eradicate weeds
- It is difficult to breed host specific for weed control.

5. Chemical weed Control

- This involves the use of herbicides which are classified according to:
    a. Use
    b. Mode of action
    c. Time of application
- Herbicides can be applied as sprays, powders, granules or dust.

a. Use:

i. Selective herbicides

- They destroy plants of particular groups without harming other plants in the mixed population.
- Example: Dalapon-kills monocots (grass)
  2,4 dichloroacetic acid (2,4-D)

  2, 4, 5 trichloro acetic (2,4,5-T) kills only dicotyledonous

  plants (broad –leaved weeds.

ii. Non selective herbicides.

- e.g. Paraquat which kills both narrow-leaved and broad leaved weeds.

b. Mode of Action

i. **Contact herbicides**- applied to leaves eg propanil and Bantazone

ii. **Translocated herbicides**-Absorbed by plants through leaves or roots eg atrazine Simazine,Diuron and Alachlor.
iii. **Soil sterility:** prevent weed growth e.g. Bromacil

c. **Time of Application**
i. **Pre-planting herbicides-** applied before the crop is planted.-These are also soil sterilants such as Bromide.
ii. **Pre-emergence herbicides**- applied after the crop is planted but before the emergence of the crop or weeds e.g. Lasso in maize field.
iii. **Post –emergence herbicides-** applied after the emergence of the crops and the weeds.

Advantages of chemical weed Control

- Reduce early weed competition
- Reduces labour
- Enables cultivation of large plots
- Ensures timely control of weeds.

Disadvantages of chemical weed Control

- High concentration destroys crops
- Some Herbicides are harmful to people
- Requires proper training in handling and application
- They may be too diluted by rain water to be effective

6. **Legislative Weed Control Method**
   - This involves passing laws to control weeds especially those that are enter into the country through import.

This is applied through;
i. **Inspection** at entry points like the airports harbours, ports to ensure that those entering the country do not carry weed seeds or any other goods that may contain weed seeds.
ii. **Quarantine** to ensure that suspicious goods that may contain weed seeds can be observed for a reasonable period to check that they are free from weeds or weed seeds.
iii. **Reporting** known cases.

Advantages

- Prevent strange weeds from being introduced into the country
- It is tree to farmers.
- Not effective due to issues of smuggling of goods.

Disadvantages

- Difficult to enforce
- Does not control weeds on individual farms
- Only covers few specific noxious weeds.

Note: Legislative method cannot control weeds at farm level but only regulates the control of weeds.

TOPIC 5: CROP PROTECTION (PEST AND DISEASE CONTROL)

- Crop protection means keeping cultured plants safe from organisms that could cause damage and reduce crop yields as well as income.

Why should we protect crops/ control pest and diseases?

- In order to prevent the crops damage
- In order for the crops to produce more yields
- In order to maximise profits

Groups of field pest

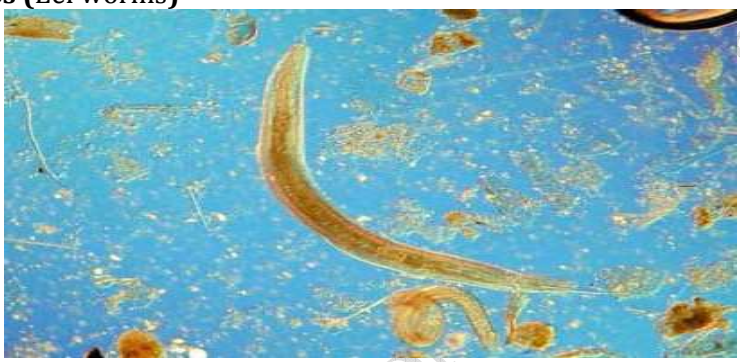
- Mammal
- Birds
- Insects
- Nematodes

Mammals/	Birds	Insects	Worms
Mice	chicken	weevil	round worm
Monkeys	guinea fowl	termite	caterpillar
Pigs	doves	locust	stalk borer
Goats	red Headed quelled	beetles	army worm
Giant rat	weaver	grasshopper	larger grain borer
House rats	vulcher	Aphids	bud worms
Warthog		fruit flies	
Hare		green grasshopper	
Antelope			

Examples of common pests of crops

a. Guinea fowls

a. Nematodes (Eel worms**)**



Nematodes: These are microscopic round worms called eel worms

They cause knots on the roots of crops.

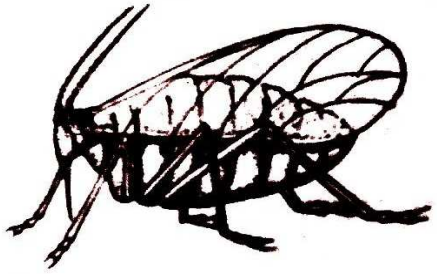
Insects

- Their bodies are divided into three regions head, thorax, abdomen
- The head has feelers or antennae that are used for
- The abdomen has a pair of legs and spiracles
- Spiracles are used for respiration un insects

Insects are grouped into three

a. Biting and Chewing Insects
- These have a pair of powerful mandibles used for eating parts of roots, leaves, stems, flowers and seeds e.g grass hoppers termites.

b. Piercing and sucking insects pests
- They have sharp needle like proboscis (stylet)
- The stylet is used for sucking juices e.g Aphids, fruit, flies, cotton stainers, mealy bugs



An Aphid

c. Boring Insects

- These have special mouth parts used for boring and chewing
- They drill tunnels into the stems, fruits or seeds and remain inside the tissues eat them e.g stalk borers weevils.

Methods of controlling pests and diseases

- Pests and diseases can be controlled in several ways such as
  i. Physical method
  ii. Cultural method
  iii. Legislative method
  iv. Biological method
  v. Chemical method

i. Physical method

- This uses human effort or mechanical devices i.e.
  - Hand picking
  - Fencing
  - Frightening of pests
  - Painting sticky bands
  - Erecting concrete foundations
  - Flooding fields
  - Using rat guards
  - Using air-tight storage facilities
  - Chilling and heating

ii. Cultural methods

- This is the use of normal husbandry practices that prevent or reduce multiplication of pests and diseases e.g.:
  - *Tilling the soil:* This exposes soil pests or soil-borne diseases to the sun for them to die before planting og crops.
  - *Rotating the crops:* This kills pests or reduces disease occurrence because not all crops are attacked by the same pests and diseases.
  - *Planting early:* Crops establish before pests and diseases build upor crops escape late pests and diseases because they mature early.
  - *Planting clean and health seeds*
  - *Removing volunteer plants*
  - *Weeding early*
  - *Maintaining a recommended plant population*
  - *Applying manure or fertilizers properly*
  - *Destroy crop residues*
  - *Intercropping or mixed cropping.*

iii. Legislative methods

- This method does not necessarily kill pests and diseases but emphasis is compliance to the set laws and standards so that entry and multiplication of pests and diseases is controlled.

a. Prohibition

- Laws and regulations are made country wide restricting entry of some agricultural materials suspected to be a source of infection.
- In air ports and migration points planting materials and animals are inspected before entry into the country and certified free of pests and pathogens.

b. Quarantine

- Imported seeds, plants and animals are put in isolation and observed in sealed compartments providing a period long enough for any disease to symptoms to appear.
- If these materials are observed to have any symptoms of any diseases, they are destroyed at the expense of the importer.

c. Notification order.

- Notification orders ensure that serious pests and diseases are promptly identified and dealt with before they cause too much damage. The order requires that occurrences of notorious pests or diseases must be reported immediately to the appropriate authorities or police. Pictures of such pests and diseases are displayed country wide and in immigration points. Army worms and red locusts are notifiable pests.

d. Closed season

- This is the period where farmers are not supposed to leave some crop residues in the field to starve the pests so that they do not survive to the next growing season. For example, tobacco.
- In Malawi the three regions observe different periods of closed season for tobacco because they receive rainfall at different times which dictate different growing periods of tobacco.

Operations	**Southern R.**	**Central R.**	**Northern R.**
Early sowing dates	15 July		7 August
Early transplanting Dates	1 October	23 July	21 October
Dates for uprooting and destroying remaining seedlings from nursery	31 December	31 December	31 January
Dates for uprooting Stalks and regrowth from the field	1 may	15 May	30 May

Source: Guide to Agriculture production by MoA

e. Seed certification

- Seeds are inspected and certified before being sold or distributed to farmers by national seed company and the government. Farmers are not allowed by the low to plant uncertified seeds of tobacco and maize.

iv. Biological method

- This is the use of living organisms to control pests and diseases.
- This includes the use of:

a. Predators

- These are animals that depend on other animals for their survival. For example chickens and crows control cotton strainers and army worms respectively.

b. Parasites

- These are organisms which live in or on another organism as their host in order to get food or shelter. Grasshoppers are destroyed in this way by diptera.

c. Pathogens

- This is the use of some disease causing organisms to control some diseases. For example, bacteria and is used to control larvae of beetles and coffee berry moths while viruses are used to army worms.

Advantages of Biological method

- It is safe
- Effective for several years
- Does not pollute the environment

Disadvantages

- The only disadvantage is that it requires expertise and thorough knowledge of the ecosystem and the behaviour of both pests and the controlling agents.

v. Chemical methods

Forms of Chemicals

- Powder
- Dust
- Liquid
- granules
- gas

How do they kill pest / control pest

- Stomach poisoning
- Respiratory poisoning
- Systematic poisoning

Advantages of chemicals

- It requires less labour as on individual farmer can apply chemical on the large piece of crop field
- Faster than other methods e.g. physical or cultural
- It is easy to use because instructions are provided on the label
- More dependable than legislative control
- It is used when it is needed and this avoids wastage of money
- It produces results quickly

Disadvantages

- Very expensive to buy chemicals

- Some chemicals are not environmental friendly and cause pollution to the environment
- It kills other beneficial organisms in the soil
- Some chemicals have health hazards to people
- Where instructions are not properly followed chemicals can ineffectiveness of the chemicals
- Chemical application requires special skills.

Factors to consider when applying chemicals

- Identification the type of pest you want to control since not every chemical can control
- Consider how expensive the chemical is
- Consider the effectiveness of the chemical
- Consider the health hazards of the chemical to own life
- Consider whether the chemical is environmental friendly
- Consider the amount of chemicals to be applied.

Integrated pest management (IPM)

- This is the use of more than one method in controlling pest and diseases
- This means that one method not 100% effective to control pest and diseases
- Therefore you should consider that:
  1. Laws are compiled in order to minimize multiplication of pest and diseases
  2. cultural methods are always used
  3. biological methods should be encouraged
  4. physical methods should be applied where resources are available
  5. chemical methods are used sparingly

TOPIC 6: CROP SYSTEMS

- A crop farmer is to business minded person who grows crops to maximize the yield in order to have more food as well as a lot of income.
- Different crop systems are therefore and some of these system assist the farmer to be bailed out poverty and to solve other serious problems e.g soil erosion and land degradation

Examples of crop systems

1. Shifting Cultivation

- This is the growing of crops on a piece of land given period of time until soil become exhausted and land as abandoned completely for a new one
- This involves clearing of the both and burn them
- The ashes from the burnt wood get as fertilizer for the first year of the growing period
- Clearing of the bush is done by the tools e.g. panga knives there is no use of fertilizer

Advantages

- It is cheap because it does not use fertilizer or other inputs
- The burning of the bush helps to control pest and diseases
- It does not require special skills

Disadvantages

- It is not sustainable and environment friendly
- It leads to soil erosion on land is left bare
- It only works where there is a lot of land
- Burning of land burns useful plant nutrients

2. Bush Fallowing

- This is the growing of crops on a piece of land at a given period of time until the soils become exhausted then abandoned for a new field temporally for it to regain to fertility.
- Because of the changing of land it is also referred to as a land rotation
- In most causes this system is to similar to shifting cultivation

Advantages

- It is cheap since it does not need any capital
- It uses simple tools
- It maintain the fertility through the following period
- It does not need special skills

Disadvantages

- It encourages deforestation
- It causes soil erosion
- Lead to little yields
- It re quire a lot of land

Why shifting cultivation and bush fallow should be discouraged these days

- There is high population that lead to land shortages per each individual
- the two systems are not suitable and environmental friendly as more trees are cut in order to open new fields
- Since agriculture is considered as business the two systems cannot apply because they lead to low yield in succession years.

3. Mono Cropping

- This is the growing of one crop on the whole farm every year.
- Choice of a crop most suitable for a given area, Identification of capital and managerial ability makes mono cropping a Success.

Advantages

- It produces the highest possible profit since they grow only the most suitable crop for the environment.
- It facilitates farm mechanization because the Land area is usually large.
- It saves costs because mono cropping is done on a large scale and large quantities of inputs required are bought in bulky which is cheaper.
- It simplifies farm management because Concentration is given to one type of crop.
- It reduces the amount of starting capital.
- It ensures specialization to the part of a farmer and becomes an expert.

Disadvantages

- Encourages building up of pests and diseases because the growing of one type of crop makes the pests and diseases keep on multiplying.
- The risk of Loss or disappointment is high due to drought, floods, lowering of prices etc.
- The Soil becomes exhausted easily and Yield for subsequent years decrease.

4. Monoculture

- This is growing of only one crop on a piece of land during the growing season and each plot on a farm has a pure stand.

Advantages

- It facilitates the use of machinery because each plot contains a pure stand.
- It eliminates of any competition from other crops since there is only one crop to make maximum use of resources in the environment.
- It is easy to use chemicals in a plot of pure stand.

Disadvantages

- It increases the rate at which pests and diseases spread since there are no other crop barriers to check or slow down the invasion.

5. Mixed Cropping

- This is the practice of growing two or more crops on the same plot at the same time.

- Other names of mixed cropping are:
  - Intercropping
  - Inter planting
  - Multi culture
  - Poly culture

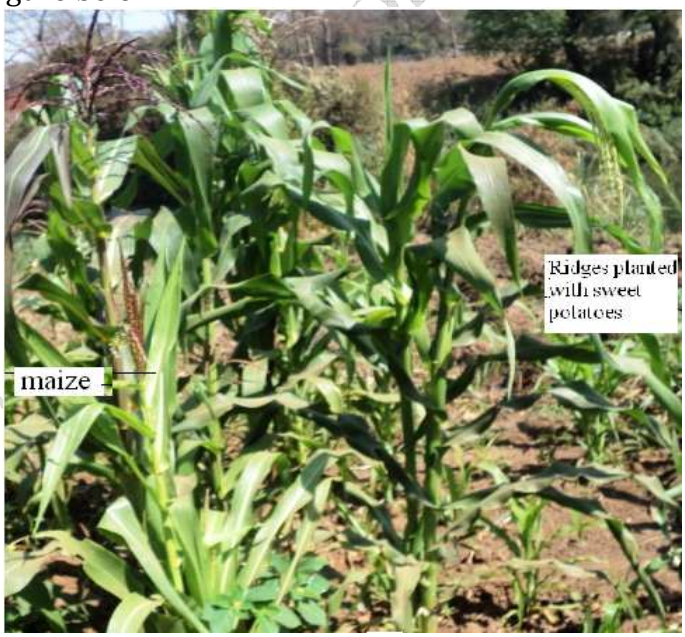
There are three categories for mixed cropping:

i. Intra-row mixed cropping

- Two or more crops are grown within the same ridge or on the same planting stations.

ii. Inter-row mixed cropping

- One crop is grown between the rows of another crop.
  See figure below.



Inter cropping (maize and sweet potatoes)

iii. Relay- intercropping

- The second crop is sown in the plot while the first one is still growing or established.
- Relay Intercropping is also known as phased planting

Advantages of intercropping

- It saves labour since some operations are done once for all crops.

- Increases the total yield per hectare
- Saves land since the same land is used is used for more than one crop.
- Reduces the risk of crop failure since the farmer can relay on the other crops if one fails.
- Enables the crops to benefit from one another.
- Reduces the spread of pests and diseases.
- The mixture of crops Provide adequate soil cover to reduce soil erosion.

Disadvantages of intercropping

- Mechanisation is difficult.
- Requires large starting capital
- It is difficult to use pesticides, fertilizers or herbicides
- Requires a wide range of knowledge and skills to manage different crops
- Different crops may shade one another or compete for food and space

6. Continuous Cropping

- This is the practice of growing crops on a piece of land every year without fallowing or resting the land.
- This system is mostly practiced by commercial estate farmers with high dependence on fertilizers and pesticides.

Advantages

- Ensures 100% utilization of land resources
- Conserves the soil since the soil is under cover most of the time and this reduces erosion.
- Ensures food security or sufficient cash.

Disadvantages

- Exhausts soil fertility since soil nutrients are removed by the crops every year.
- Results in over cropping which destroys the soil structure.
- Results in multiplication of pests and diseases and other parasitic weeds.

7. Crop Rotation

- This is the practice of growing different (changing crops) on a piece of land in a particular sequence every year.
- To decide on the crops to grow a farmer considers climate, soil type, amount of land, capital, labour available and managerial ability.

Principles to follow when practicing crop rotation

- Alternate tap (deep) rooted crops with shallow or fibrous rooted crops.
- Alternate leguminous crops with non leguminous crops.
- Alternate heavy feeder crops with light feeder crops.
- Alternate crops that are resistant to specific diseases with susceptible crops to those diseases.
- Alternate crops with good soil cover with those having little soil cover.

Advantages

- Ensures that plants make full use of soil nutrients from different layers
- Maintains or improves soil fertility when legumes are included in the rotation
- Controls pests and diseases by breeding their life cycle
- Controls parasitic weeds which are host specific
- Reduces soil erosion when good cover crops are included to cover the soil from rain drops impact and run-off crops
- Ensures a more even distribution of labour demand through out the year
- Spreads out financial risks over cereal crops

Disadvantages

- Results in less farm income compared to mono culture since some crops in a rotation may have low commercial value
- Requires more labour since some of the crops may need low commercial crops
- Requires more land to accommodate all the crops
- Requires different skills in managing the crops

A six year rotational plan

Year	**Plots**					
1	Maize	cassava	cotton	G/beans	millet	G/nuts
2	cassava	cotton	G/beans	millet	G/nuts	Maize
3	cotton	G/beans	millet	G/nuts	Maize	Cassava
4	G/beans	millet	G/nuts	Maize	Cassava	Cotton
5	millet	G/nuts	Maize	Cassava	Cotton	G/beans
6	G/nuts	Maize	Cassava	Cotton	G/beans	

8. No – Till Cropping

- This is also known as Zero tillage or Minimum tillage.
- This system involves clearing the land and plant crops without tilling or making ridges.
- Weeds are controlled by applying pesticides or using cultivators.

Advantages

- It conserves the soil since it is not loosened by tillage which would make it easy to erode by water or wind
- Saves labour since Ploughing and Ridging are not required
- Crop husbandry practices are completed on time
- Maintains soil structure
- Saves money
- Can be effectively used in hilly areas where machinery could not be used

Disadvantages

- May not improve productivity of clay soils
- Herbicides used for controlling weeds are expensive

9. Biological / Organic Farming

- This is the system where crops are grown using organic inputs.
- This system is also known as Ecological Farming because it does not interfere with ecological balance in the environment.
- Hence in this system, weeds, pests and diseases are controlled
  - Physically
  - Mechanically
  - Culturally
  - Biologically

Advantages

- It prevents river and lakes from being polluted with washed fertilizers and chemicals
- It protects useful insects
- Improves soil structure through the use of manure
- It is cheaper to make and use manure than to buy fertilizers
- Reduces the chances of poisoning
- Keeps the ecosystem in the state of balance

See figure below

Fadihebia abida (Msangu) Used for organic farming as organic fertilizer and for soil conservation measure.

Disadvantages

- Organic inputs may not be as quick as inorganic in producing results.

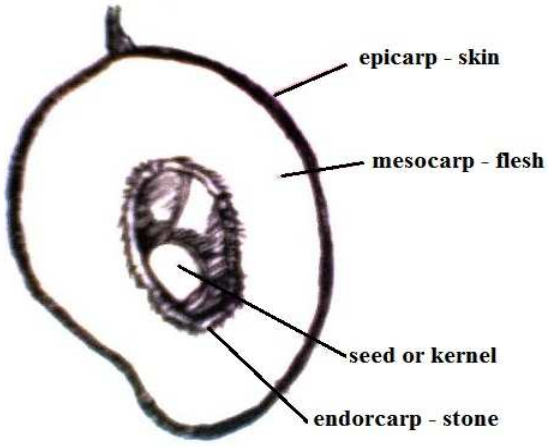
TOPIC7: FRUIT CULTIVATION

IMPORTANCE OF FRUITS

- Fruits are a source of raw materials to local industries for example juice from mangoes, oranges, guavas, pineapples, grapes etc
- Fruits provide people with income after selling
- Fruits are a source of valuable food nutrients such as Vitamins and Minerals, Carbohydrates, Proteins and Oils
- Fruits provide employment
  NB: Many people are self employed or offered paid Jobs when they are in fruit production in orchards.
- Fruits provide foreign currency
  NB: Although production level of fruits in Malawi is still low, fruits can provide a great deal of foreign currency if they are exported to other countries.

MANGOES

Varieties of Mangoes



The Structure of a Mango

Local Varieties

- Boloma, Domasi, dodo, waka, kambululu, kapantha.
- Despite having good flavour, these varieties have a lot of fibres.

Exotic Varieties

1. Haden

- It is about 400-700g large
- Matures early
- Suitable for hot dry season
- They are well coloured with excellent flavour
- They are easily attacked by anthracnose disease.

2. Zill

- It is 300-400g in size
- Matures early
- Fruits are scarlet to dark red when ripe
- Suitable fro all typical mango areas
- Have excellent internal quality

3. Irwin

- Medium size of about 450g and 12 cm long
- Early maturing
- Suitable for most areas
- Fruits are elongated and slightly flattish.
- Has excellent internal and external quality

4. Davis-Haden

- It is up to 900g large.
- It is suitable for hot dry areas.
- It is resistant to anthracnose.

5. Palmer

- It is 600-700g large.
- It is late maturing
- Produces elongated fruits.
- Easily attacked by bacterial black spot.

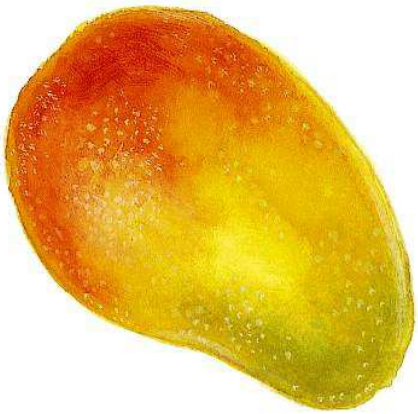
6. Kent.

- It is up to 900g large
- It is late maturing.
- High yielding.
- Suitable for hot areas.

7. Keitt

- It is large up to 900g
- It is late maturing.
- It bears plump thick fruits.

8. Anderson.



Anderson variety of mango

- It is 28 cm long and about 1kg large.
- It is a very late maturing variety.
- It is suitable for canning.

When choosing a variety for an orchard, the following factors should be considered;

- It must be high yielding.
- It must be resistant to diseases
- It must have excellent internal and external qualities
- It must be early maturing or the one that matures later than existing varieties in order to extend the mango season.

Husbandry Practices for Mango Growing

a. Choice of Site.

- Choose a site which has deep, well drained fertile sandy loam soils
- Choose an area that has 5.5-7.5 soil PH.
- Choose an area which is not above 600m altitude for high yielding because yield of mangoes decrease with increase of altitude.
- Choose an area that receives a minimum annual rainfall of 650mm.

b. Land preparation

- Prepare planting holes (90x90x90)cm two months in advance.
- Refill the planting holes with decomposed manure of about 5-10kgs.
- Make spacing between planting stations 9mx9m but in infertile soils planting stations should be wider.

c. Planting

- Transplanting should be done at the beginning of the planting season for successful establishment.
- Use sub soil left from planting holes to make basins around each tree to hold water
- Water the seeding immediately after transplanting

d. Mulching

- This should be done to conserve the moisture by reducing the rate of evaporation.

e. Weeding

- Clear all the weeds around the basin
- Slash the rest of the area regularly.

f. Fertilizer application

- Mangoes are not heavy feeders but application of manure and fertilizers is necessary.
- Apply 5-10kgs of manure at the beginning of rainy season
- The amount of fertilizer applied varies according to age of the fruit tree and type of fertilizer.

Age of fruit tree	Type of Fertilizer and amount in grams		
	CAN	Triple Super Phosphate	Muriate of Potash
1	100	20	125
2	200	40	250
3	300	60	375
4	400	80	500
5	500	100	625
6	600	120	750
7	700	140	875
8	800	160	1000
9	900	180	1125
10	1000	200	1250

g. Harvesting

- Harvest physiologically mature fruits by hands and should not fall off on the ground to avoid bruising.
- Fruits for export should be packed in trays of 5kgs each with 12-30 fruits in a single

h. Pests of Mangoes

1. **Mango Stone Weevils (Sternchetus mangiferae)**
   - It enters the fruit during the early stage of fruit development.

- It damages the seed
- Fruits may fall off or rot or may have hard white areas in side.
- The pest can be controlled by burying dropped fruits and keeping the orchard clean.

2. **Mango Scales (Coccus mangiferae) and Coccus acuminatus**
   - These are insects which attack the leaves leaves, stems and fruits.
   - They produce sticky liquid (honey dew).
   - They can be controlled by spraying the trees with 20 WP at 85 g in 14 litres of water

3. **Fruit Flies (Ceratitis capitata)**
   - Flies lay eggs on the fruit
   - Shinny white maggots hatch and enter the fruits.
   - Fruits change colour before they are ripe.
   - Part of the flesh becomes liquid.
   - The pest can be controlled by
     - Collecting and burying fallen fruits
     - Spraying Fenthion 50EC at 1 ml per litre of water
     - Harvesting fruits before ripening.

i. Diseases of Mangoes.

Disease	**Symptoms**	**Control**
Anthracnose	Premature ripening of fruits Leaf spots (discoloration) Black spots on fruits Rotting of fruits.	Spraying Benoml (Benlate) 50 WP at 15 g in 10litres of water.
Powdery Mildew	Shedding off of flowers and immature fruits White substances appear on flowers.	Spraying Benoml (Benlate) 50 WP at 15 g in 10litres of water.

Questions

- Calculate the total amount for each of the fertilizers below that a farmer may need for 20 mango trees which are 8 years old
  - CAN
  - Muriate of Potash
  - Tipple Super Phosphate

TOPIC 8: CROP IMPROVEMENT

What is crop improvement?

- The process of increasing the productivity of cultivars
- It began with early farmers
- They saw that some crops were superior and kept seed from those for the next growing season to maximize production.
- Plant breeding makes crop improvement possible

Crop improvement depends on two factors

- Inherited traits (genetics)
- The environmental conditions in which the crop is grown.

Aims of Crop Improvement

- To increase the average crop yield-(quantity)
- To improve the quality of the yield

Objectives and aims of crop improvement

- To increase the biomass (adequate quantity of dry matter
- To improve partition-ability to divert the biomass to the desired harvestable portion of the plant
- To increase resistant to diseases and pests.
- To increase seasonal adaptation to match growth with maturity
- To increase tolerance to harsh environmental conditions

Quality

- To achieve uniformity between individual crops
- Increase the nutritive value
- Improve dwarfness
- Improve processing qualities
- To increase market values of crop products

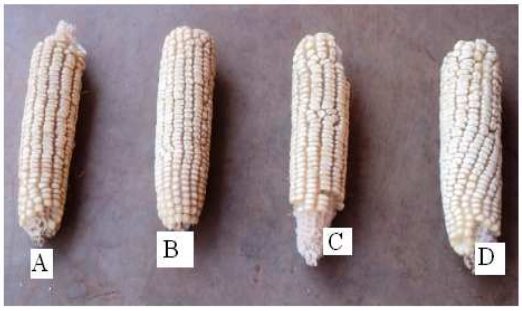
Methods of crop improvement

Introduction

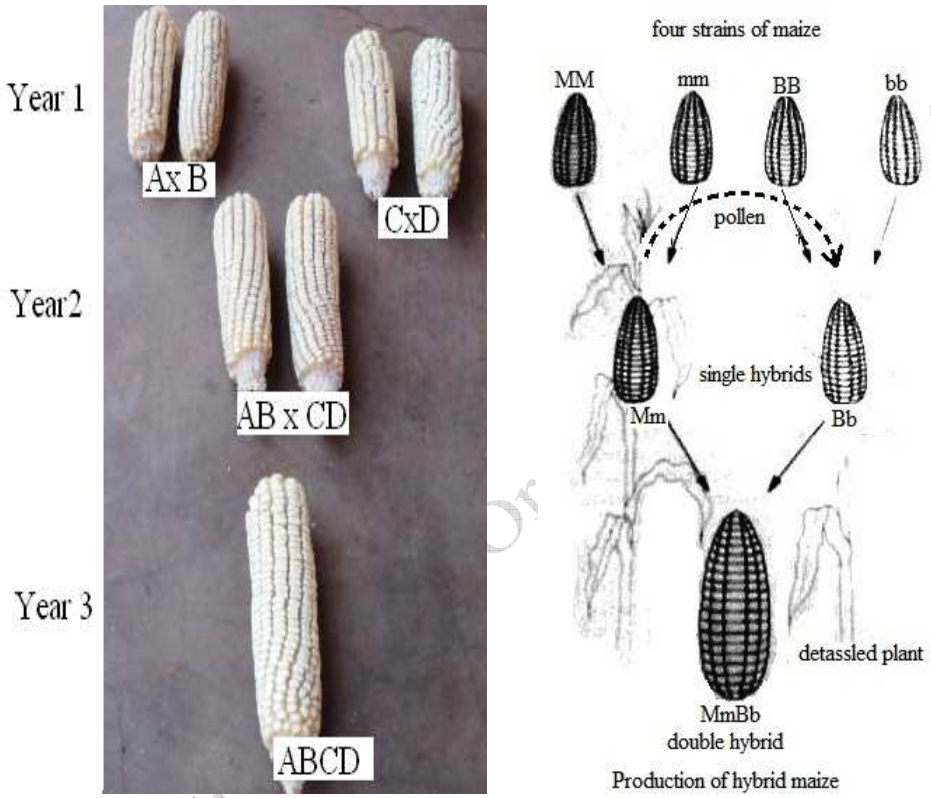
Selection

- A farmer wanted to improve the maize variety but had four varieties of different characteristics
    - Variety A: Disease resistant
    - Variety B: Dwarf height that resisted lodging by wind
    - Variety C: High yielding
    - Variety D: Early maturing.

See figures below.



Four varieties of maize with four different dominant characteristics



- Using the diagram show how a farmer can obtain one variety with all the four characteristics in three years time

A x B C x D

AB x CD

ABCD

- The last variety arrived at will have the four characteristics, one from each of the varieties that a farmer had at first.

Hybridization

- This is the process of cross pollinating two crops or varieties with different characteristics in order to produce a new variety that combines the good qualities of the two parent crops .
- There are three steps of successful hybridization
- Choosing parents
- Self –pollinating the parent lines
- Cross-pollinating the pure lines

Choosing Parents

- Parental varieties must have superior characteristics that complement each other i.e.
  - A crop that is high yielding but susceptible to diseases should be crossed with a low yielding variety that is disease resistant
  - A higher yielding variety that is taller (lodges easily) to be crossed with a low yielding dwarf variety.
  - A late maturing variety high yielding variety to be crossed with an early –maturing low yielding variety

Self – Pollinating the parent lines

- This is the inbreeding process of hybridization.
- It is done in order to develop pure lines
- The chosen plants are self- pollinated for several generations (5-6).
- This process results n reduced plant vigour (Inbreeding depression)

Cross-pollinating the pure lines

- Pollen is collected manually from one pure line and transferred to the stigma of the flower of another pure line.
- This results into increased plant vigour.
- The new vigour acquired by the crop through cross breeding is called Hybrid Vigour or Heterosis.
- Accidental self- pollination is prevented by removing or killing the anthers (male parts) before maturing. This process is called Emasculation.
- Pollination by the other foreign pollen is prevented by covering the female parts of flower parts of the flower with a plastic bag.

TOPIC 9: CROP STORAGE AND PROCESSING

- Most crops are produced in growing season but are needed throughout the year
- Proper storage and processing mechanisms can make the produce available even when it is not in their growing season.
- Processing means handling the crops and preparing them for consumption or storage by changing their form into finished products that consumers need.
- Storage on the other hand is the preservation of the produce for future use.

Processing of different crops

1. Maize and Ground nuts

a. Stripping the maize sheath or pods

- This involves removing the husks or the shells.

Advantages

- Husks/pods prevent thorough drying of the grain by preventing the air from reaching it by trapping moisture the shell/cob.
- The moisture in the covers encourages the moulds.
- It is difficult to apply pesticides to the grain.

b. Shelling the grain

- This is the removing of the grain.

Advantages

- Speeds up drying of grains.
- Shelled maize/groundnuts takes up less storage space.
- It is easy to weigh and know the exact amount of produce available.

c. Drying the grain.

- Air dried
- Sun dried.
- Grain for storage should be dried to 10-12% moisture content.

Importance for drying before Storage

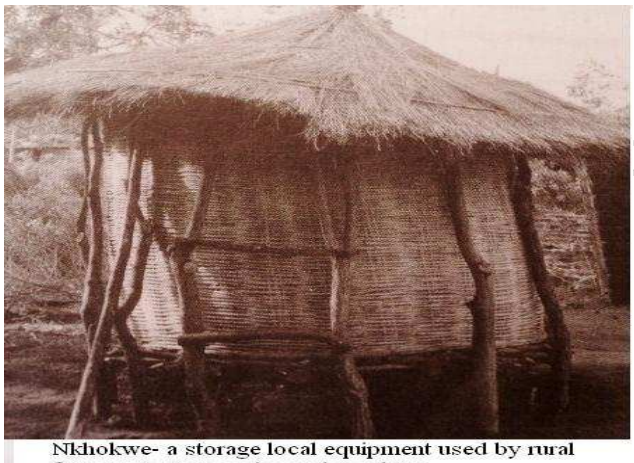
- It prevents moulds from developing on the grain.
- It makes the pericarp strong enough for to resist storage pests.
- It reduces respiration rate in the grain.
- It prevents the grain from sprouting.

d. Cleaning the Grain.

- This can be done by winnowing to remove the chaff.

Storage of maize and groundnuts

- These can be stored in;
  - Baskets
  - Sacks
  - Tins
  - Drums
  - Grain stores
  - Granaries (nkhokwe)
  - Silos



Nkhokwe- a storage local equipment used by rural farmers to store maize and sorghum

- Commercial maize farmers store their maize in cool dry shaded place.
- The maize is sprayed with **Novatellic** liquid chemical just after it is harvested from the field and before shelling.
- This is to kill all the pests like weevils that might be transferred from the field.
- The spraying of the chemicals is continuous as long as the presence of weevils has been noticed.
- Another method of treating the stored maize is through fumigation.
- A more stronger and poisonous chemical called **Gas toxin** is used.
- This chemical is in tablet form. See Figure below.

Gastoxin Novactellic

Chemicals for treating storage maize

- The storage place is made air tight and the stack of maize usually in bags is covered by non porous plastic sheet while the tablets are randomly spread amongst the bags on the sack.

Precautionary Measures to be followed when applying poisonous chemicals.

- Because the chemicals are poisonous, the following precautions need to be adhered to;
- Wear a protective gear to cover the body as well as mouth and nose to prevent direct contact with the chemicals and inhaling them respectively.
- Do not eat anything while applying chemicals
- Wash the body thoroughly with water and soap after finishing applying chemicals.
- Recently a certain storage weevil has emerged which is resistant to any chemical from Nantipwiri in Chikhwawa.
- The only way of treating this weevil is through burning the attacked maize.

Characteristics of a good Storage place for Maize and Groundnuts

- It must be leak proof and dry to prevent moulds
- It must be cool, away from the sun to prevent respiration rate which spoils the grain.
- Must be hygienic to prevent multiplication of pests and pathogens.
- Must be air tight to keep pests and pathogens away.

Processing and storage of Sweet Potatoes

Preparation Steps for Storage include

a. Cleaning.

- Remove all dirt and debris from the tubers to keep away fungi and other pathogens into the storage place.

b. Selection

- Only tubers that have no bruises or cuts or any damage should be selected for storage.

c. Curing.

- Spread the tubers in a cool dry shaded place which is 29-30^{o}c. And the relative humidity of 85-90% for about five days.

Advantages of curing tubers

- Enables the tuber skin to get thick or tougher for easy storage.
- Enables the healing of wounds in the tubers which prevents future fungal infection.

d. Piling.

- Handle the tubers carefully when piling

- Do not stack them too high (not more than one metre)
- Put grass or banana leaves on the floor to cushion the tubers.

Storage of Sweet Potatoes

- Store them in a cool dry dark place.
- Sweet potatoes are best stored in a pit lined with a layer of sticks and covered with grass or leaves.
- At the top the pit should be covered with loose soil.
- Ventilation holes should be made using short bamboos cuttings to prevent the build up of moisture which would encourage sprouting or moulds.

3. Cassava

- Fresh cassava can be peeled sliced and dried in the sun.
- The dried pieces (makaka) can be stored in sacks and stacked for future use.

Advantages of storing processed cassava

- Reduces the toxicity of tubers.
- Improves the palatability of the produce
- Makes the perishability of the produce stable for them to stay longer for storage.

4. Storage of Mangoes.

- Mangoes are very perishable fruits and can best be stored while processed in the form of juice, chutney and at jar.
- Fresh mangoes can be stored for the short period through the following procedures.
  i. Wiping off any latex
  ii. Selecting fruits that are in good conditions.
  iii. Cooling fruits quickly to 7-10^{o}c.
  iv. Disinfecting the fruits to prevent spread or multiplication of fruit flies.

TOPIC 10: PASTURE PRODUCTION

Importance of pastures

- Pastures are used as animal feed
- Pastures help to conserve soil and water.
- Pastures add fertility to the soil
- Pastures control pests and diseases
- Pastures improve soil structure.
- Pastures are used as animal beddings
- Pastures are also used for thatching houses and animal shelters.

An example of pasture

Elephant grass

- Pasture establishment is the deliberate sowing of posture seeds into the field

Methods of sowing pastures

1. **Broadcasting/ scattering**
   - For the seeds to land on the ground well they should be mixed with
     - sand
     - saw dust
     - fertilizer

Advantages

- It is the quickest way of sowing pasture
- It is easy as it does not need nitrate skills
- It saves time
- It is cheap it requires less labour

Disadvantages

- Some seeds can easily be eaten by birds or blown off by wind

- Some seeds can be burned deep hence they fall to germinate
- Some seeds do not fall on desirable places
- Plant population is not maintained as some seeds just get bapaed of bad places
- Difficult to weed the field
- Difficult to apply fertilizer

2. Drilling Method

- This is the sowing of pastures on trenches

Advantages

- It is more efficient than broadcasting methods as the seeds are not wasted
- Easy to apply fertilizer
- Weeding is not difficult

Disadvantage

- It requires more labour as compared to broadcasting method
- It is time consuming if done manually
- It is expensive it is done mechanically

3. Over Sowing Method

- This is the sowing of pasture in an already established one especially natural pasture in order for the new pasture to develop well the old natural pasture is burnt to reduce it.

Advantages

- Yielding of the combined pasture is high
- Protein content tend to be high because of introduction of improved pasture
- Dry matter content tend to be increased than in a pure stand
- Quality of the pasture is improved with introduction of new improved pasture

Disadvantages

- The new sown pasture competes with an old existing natural pasture over sunlight, space and nutrients

4. Under sowing

- In this method the pasture seeds are sown under the arable crops in the field of maize.

Advantages

- The farmer gets extra harvest of pasture from field
- Reduces of problem of land
- Land preparation is easy as it is done only once

- The arable crop protects the young sown crop from adverse whether condition
- The farmers get more total yield from one field

Disadvantages

- The product of each crop is less than in a pure stand of these crops.

5. Vegetative method

- This is the means of establishing pasture using part of already developed pasture e.g. cuttings root system.

Advantage

- It is easy to maintain genetic make-up
- Only way of propagating pasture that do not produce viable seeds
- They are readily available to farmer

Disadvantages

- Transferring of diseases to new plants is high
- Some procedures require special skill
- Difficult to introduce variation
- This things are bulky
- Cannot be kept for a long time without them loosing quality

Procedures in pasture establishment

1. **Land Preparation**
   - Clearing the field
   - Ploughing the field
   - Levelling the field and breaking the clods into fine filth

2. **Time of Sowing**
   - Sowing should be done at the beginning of the rainy season

3. **Seed Selection**
   - Select the seed that of good quality to ensure high germination rate.
   - In order to have quality seeds the following formula should be followed
   - Pure seed contents (PLSC) = Purity % x Germination %

Factors to consider when selecting pasture seeds (grasses and legumes)

- Adaptability of the pasture to the environment
- High overall dry matter production per unit area
- High feed value
- The proposed duration of the pasture of the pasture
- Compatibility with other species

- Resistance to local pest and diseases
- Proposed method of stylization i.e. pastures should be chosen depending on the method of its utilization e.g. hay, silage, grazing
- Continued digestibility of the pasture
- The role of the pasture in the rotation

4. Calculation of Seed Rate

- Seed rate is the amount of seed in (kg) needed per hectare per given type of crop.

Seed Rate = Expected plant population : seed size : purity % : germination %

Hectare

OR : Expected plant population/ha

Seed size x purity % germination %

1. Calculate the seed rate of buffel grass with the used size of 300,000 seeds/kg, purity 80% and germination % 30 % and expected population 900, 000 plants.

$$\frac{900\,000 \text{ seeds}}{1 \text{ ha}} \quad \frac{300\,000 \text{ seed/ kg}}{1} \quad \frac{80}{100} \quad \frac{30}{30}$$

$$25$$

$$\cancel{100}$$

$$\cancel{8}$$

$$2$$

= 12.5 kg/ha

Plant Population

- Seed rate x seed size x purity % x germination %

$$\frac{12.5 \text{ kg}}{\text{ha}} \times \frac{300\,000 \text{ seed}}{\text{kg}} \times \frac{80}{100} \times \frac{30}{100}$$

12.5 x 30 x 80 x 30

= 900 000 seeds /kg

Factors that affect seed rate of pasture

1. Purity of the seed

- Seed that are mixed trashes may have higher seed rate while pure seeds tend to have lower seed rate

2. **Germination Percentage**
   - Seed with high germination percentage tend to have lower seed rate while those with low germination % have relatively higher seed rate

3. **Size Of Seed**
   - Seed which are smaller in size have low seed rate while those bigger in size have higher seed rate

4. **Pure of Mixed Stand**
   - There should be reduced seed rate per stand in a mixed stand but the pure stand to have higher seed rate

5. **Soil Tilth**
   - Land which is well prepared with fine soil tilth has seed rate while the seed rate because some seeds are buried deep and fall to germinate

6. **Growth Habit of the Species**
   - Large vegetative growth need lower seed rate

7. **Methods of Sowing**
   - Some methods require more seeds because the reduce germination percentage e.g. broadcasting than drilling method that require lower seed rate

Seed Treatment for Pasture

i. Hulling

- Remove of the pods from around the seed by tradition mortal pounding to be followed by winnowing.

Advantage

- It increase the rate of seed germination
- It makes pelleting of the seed easier
- Ensures even distribution of broadcasted seed e.g. Caribbean style

ii. Scarification

- Softening of hard testa to speed up germination by using hot water, scratching or chipping with machines

iii. Inoculation

- This is mixing legumes seeds with correct Rhizobium bacteria before sowing for successful nodulation and nitrogen fixation.

iv. Pelleting

- The practice of sticking a thin layer of materials e.g. lime, gypsum or rock phosphate around the seed to improve the pasture establishment by correcting the soil pit or soil nutrient deficiencies
  NOTE: Gypsum is not recommended in pelleting legume seeds as it increase acidity

  which kills rhizobium bacteria

Sowing

Any of the five methods of sowing can be followed as follow

- Broadcasting
- Drilling
- Under sowing
- Over sowing
- Vegetative propagation

Fertilizer application

- To ensure fast growth of pasture fertilizer has to be applied as follow.

Grass Pasture

- 220kg/ha of 20:20:0
- 110 kg/ha of super phosphate

Legume Pasture

- Mixed
- 220 kg/ha super phosphate
- 85 kg/ha of CAN

Pure Legume

- 220 kg/ha super phosphate

TOPIC 11: PASTURE MANAGEMENT, UTILIZATION AND CONSERVATION

- Pasture like any other crop need to be well cared to ensure prolonged high yield.
- In order to manage the pasture well, the following need to be done
  1. Fertilizer application
  2. Controlling weeds
  3. Pests and disease control
  4. Pasture conservation

i. Fertilizer Application

- Apply 23:21:0 at the beginning of the rainy season
- CAN should be applied after each cut and grazing
- Super phosphate is applied to legumes at the start of each season to promote nodulation and nitrogen
- Apply potassium to cut and carry pasture because removal of fresh folder rapidly depletes soil potash

Note

Nitrogen fertilizers are only applied to grass pastures because legumes have root nodules that have the capacity of fixing nitrogen.

ii. Controlling Weeds

- Some weeds are edible by livestock while others are poisonous to animals. However all weeds affect the development of pasture especially legumes
- Weeds can be controlled in different ways
  i. Weeds in broadcast pasture can be controlled by hand weeding, selective hoeing, slashing or mowing
  ii. In forage crops weeds are controlled mechanically
  iii. In pure grass legs spraying of herbicides can control the weeds.

iii. Grazing Management

- To obtain high level of livestock production grazing has to be properly managed so that there is no waste of pasture or overgrazing.

A. Follow controlled stocking rates

- Stocking is the total number of animals per unit area
- Understanding should be avoided as it can lead to waste of pasture.
- Overstocking should also be avoided as it causes over grazing.

B. Match grazing to pasture carrying capacity

- Maximum number of animals to be fed in a given area or pasture
- Carrying capacity depends on yield potential and quality of the pasture
- Providing sufficient grazing intervals (rest period)
- The rest period must be long enough to allow the pasture to recover.
- The rest period should not be too long as the pasture may over-mature.
- The grazing methods that give rest period include

i. rotation grazing
ii. strip grazing
iii. cut and curry
iv. differed grazing

i. Rotation Grazing

- This allows the movement of animals at regular intervals around a series of paddocks so that each paddock has a period of grazing and a period of rest of recovery. A grazing period of 2 weeks should be followed by a rest period of 4 weeks.

Advantages of strip grazing

- Allow pasture to be used more completely
- It ensure availability of high quality pasture each day
- Pasture is eaten when it is fresh digestive and high crude protein content

2. Zero Grazing (Cut and Carry)

- This is the system of pasture utilized where herbage is cut daily and transported to stall feed animals

Advantages

- It ensure 100 % utilization of pasture since all the grass is eaten up
- It avoids trampling of grass and soil by livestock
- It prevents selective grazing
- Assist in disease control since animals do not move to pasture where there are risks of contracting infectious diseases
- It eliminates risks of overgrazing.

Disadvantages

- It requires a lot of labour to harvest the pasture and feed to animals
- It requires the use of machines to carry the pasture to the pens
- In Malawi however, there are some problems that lead to dominance of the use of continuous grazing and differed grazing.
  a. Continuous grazing is followed because most of the grazing land is communally owned
  b. Differed grazing is followed because of the change of the 2 permanent seasons

iii. Continuous grazing

- This is the grazing system where animals on the pasture field throughout coat any rest period.

Advantages

- It is cheap and doesn't require any fencing
- Animals are not moved regularly from one product to the other

Disadvantages

- Encourages selective grazing
- It leads to over grazing
- It leads to soil erosion
- Encourages the build up of worms
- Does not give rest period for stocking rates

iv. Differed Grazing

- In this system pasture is only grazed during the dry season and the wet season it is allowed to recover and mature.
- In Malawi animals are not allowed to feed in wet dambos in wet season for the following reasons
  a. young herbage is trampled
  b. it leads to soil compaction
  c. reduces water infiltration rate
  d. increases the risk of animals contracting liver flukes

Advantages of Differed Grazing

- It encourages availability of some feed during the wet season

Disadvantages

- It leads to over-maturing of pasture and make them less nutrients and less palatable.

Note

- Modified grazing encourage the fencing of dambos and dambo margins into separate paddock of 20- 60 hectares

C. Burning of Pastures

- This a controlled burning of pasture especially in natural grass in the dry season

Advantages

- It removes the dry indigestible herbage and gives room for the growth of fresh pasture
- it prevents bush encroachment
- it controls pest and diseases
- Reduces competition for growth between selectively grazed palatable species and ungrazed unpalatable.

Disadvantages

- Burning may destroy the legume component of the pasture hence mixed with swards should not be burnt

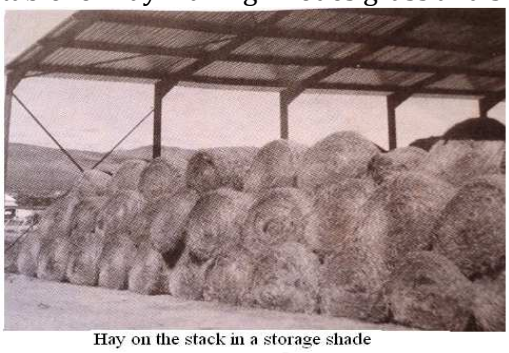
- Reduces swards vigour in case of source fire.

Conservation of Pasture

- This is the deliberate effort of keeping pasture during the period when it is in high supply so that it should be given to animals later when pasture is in short supply
- In most cases pasture is preserved in the wet season and given to animals in dry season.
- Pasture therefore can be preserved in form of
  - Hay
  - Silage
  - Foggage

Hay

- This is the herbage that is cut and preserved by partial drying.
- Examples of pasture suitable for hay making Rhodes grass and silver grass



Hay on the stack in a storage shade

Qualities of good hay

- Should be cleaned and free from foreign matter
- should be free from other impurities
- It should be dry with 20 % moisture content; too dry of it will lead to the hay loose the hay moody or rot
- It should how pleasant smell and test

Why is it important to use hay as animal feed?

- It can be kept for relatively a long time without loss in nutrients value
- It provide the cheapest source of animal feed
- It supplies most of the food values needed of energy , minerals and proteins in the dry season
- It is a good source of roughages that assist in peristalsis
- It can be sold for cash

Processes for hay making

1. **Cutting**
   - Cut just before flowering
   - Cut at 8:00 am – 10:00 am when dew is dry.

2. **Drying**
   - Partial 20 % moisture content

- Very dry hay looses vitamins
- Damp hay become moody

3. **Stacking**
   - Can be baled or compressed to use small space
   - Loosely packed hay use more

Factors affecting hay quality

- Pasture spices- Legumes have high crude protein content digestibility and palatability
- Age at cutting
- Degree of turning and drying
- Leafiness of the herbage
- presence of the foreign materials, lowers the quality
- weather at harvesting and drying
- storage of the hay, leaking storages lowers nutrients value

Silage

- This is the green pasture preserved by fermentation.

Advantages of feeding animals with silage

- It makes use of a wide range of forage e.g Napier grass, maize, sorghum and style.
- Protein percentage preserve is high than in hay
- Succulent state (juice) of green fresh forage is maintained
- It is more palatable than hay
- less vitamin A is lost than in sun-cured hay
- it is free from weed seed
- can be kept for a longer period

Disadvantages

- More expensive to make
- It requires a lot of labour
- High moisture content available in silage reduces the amount of dry matter available to live stock.

Stages in silage making

1. **Cutting**
   - Cut grass before flowering and legumes at podding
   - Partial Drying
   - Dry pasture to 65% moisture content

2. **Chopping**
   - Forage is cut into shorter length for easy compression

3. **Stacking**
   - Each layer mixed with molasses for energy

4. **Compressing**
   - Firm compacting of silage
   - In some cases a tractor run on top of silage pit to compact it and remove air

5. **Fermenting**
   - Anaerobic bacteria produce heat and lactic acid. All completely change the silo PH of silage.
     NOTE : stacking of silage has to compacted tightly to eliminate the air

   - The silage is mixed with carbohydrates concentrate e.g. molasses to provide energy for bacteria
   - Compressing helps to remove the remaining air in the layers of silage
   - The silage is covered by soil or plastic sheeting to make air tight
   - Aerobic bacteria uses the remaining oxygen until there is no oxygen
   - Fermentation is done with the help of anaerobic bacteria
   - This process produces a lot of heat and lactic acid
   - The presence of lactic acid gives the silage its pleasant
   - The lactic acid lowers the PH in the silo to for
   - The heat and the low PH kill the anaerobic bacteria hence.

Factors that affect silage making

- Speed of filling the silo
- Fineness and coarseness of the chopped material
- Amount of protein broken down during fermentation
- Water content available
- PH value of the forage
- Types of plant material used
- Availability of carbohydrates to prove energy to aerobic bacteria
- Rightness of the air seal
- Additives placed in the silo
- Water content of the herbage as high water content may cause nothing
- Age of the crop harvested for silage
- PH value of the forage
- Drainage of the area and shelter against the rain.
- Age of crop
- Fineness and coarseness of the chopped material

Foggage

- This is the standing hay left un grazed to use in the dry season
- This is a means of preserving the hay but right in the field
- The quality of foggage depends on
  1. palatability and digestibility of pasture while dry
  2. Grass/ legumes ration of the pasture
- The only advantage of foggage is that it is a cheap method of preserving pasture but its disadvantages is that it is of low quality because it is mature and more fibre, low digestibility and low crude protein content.
  See figure below.

vertiva grass used for multipurpose
Soil conservation
standing hay for animal feed.

Factors affecting the quality of pasture

- Pasture species grown
- The ration of the legumes and grasses in the pastures
- Palatability and digestibility of the pasture grown
- Crude protein content of the species
- Regenerative ability of the species.

UNIT 3: ANIMAL PRODUCTION

TOPIC 1: LIVESTOCK FEEDS AND FEEDING

Classes of livestock Feeds

Roughages

- Roughages are livestock feeds which have high moisture and fibre contents but low proteins.
- Roughages are grouped into Succulent and dry roughages.

Succulent roughages include

- Fresh grass e.g. elephant grass, guinea grass, giant grass, silage, banana stems and leucaena.

Dry roughages include;

- Hay, maize stalks ground nuts haulms,

Concentrates

- Concentrates are livestock feeds which have high proteins and carbohydrates contents but low moisture and fibre contents.
- Concentrates are also grouped into
  - Energy concentrates
  - Protein concentrates

Energy concentrates include the following;

- Cereal grains and their products
- Legume grains and their products i.e. maize, madeya, wheat meal sorghum, Millet, ground nuts, soya beans

Protein concentrates

- Meat meal, fish meal and bone meal.
- Apart from roughages and concentrates, animals are given minerals and vitamins as supplements and these are known as Additives.

Composition of feed nutrients

- Water
- Carbohydrates
- Fats and Oils
- Proteins
- Vitamins
- Mineral

Functions of Feed Nutrients

Nutrient		functions	Sources
Carbohydrates		Provide energy to the body	Cereals Potato vines Grasses Root tubers i.e. cassava
Proteins		• For body building and repair of worn out tissues • Essential component of enzymes, hormones and antibodies • Excess proteins are converted into energy	Grain legumes Meat Liver Milk Bone and fish meal.
Fats and oils		Provide energy twice as much as carbohydrates	Oil seeds i.e. g/nuts, cotton seed, soya beans. Milk Meat meal. Fish meal. bone meal.
Minerals			
i.	Calcium and Phosphorus	Bone formation Essential for milk production Calcium for egg shells	Milk Meat meal. Lime bone meal
ii	Magnesium	For health bones and teeth. Herpes to metabolize carbohydrates	Milk, cereal grins, leaf vegetables.
iii	Iron	It is part haemoglobin. It prevent anaemia	Egg York
iv	Iodine	Essential for the growth of thyroid grand which produces thyroxin Prevents goitre.	Iodized salt
v	Copper and Cobalt	Forms part of haemoglobin and enzymes while cobalt is part of vitamin B 12 Improves appetite in ruminants	Salt containing copper and cobalt Vegetables

		Prevents anaemia Maintains blood pressure Essential for bile formation	
vi	Sodium	Maintains blood pressure Essential for bile formation	Common salt and rock salt
vii	Chloride	Part of gastric juice Aids digestion	Common salt and rock salt
viii	Manganese	Helps in bone formation and enzymatic reaction Essential for protein and carbohydrates metabolism	Most feeds
ix	Potassium	Helps in the functioning of the muscles and the heart. Activates enzymes	Potassium Chloride Grass
x	Zinc	Helps in enzyme reactions	Most feeds
Vitamins			
A	Needed for good eye sight Essential for disease prevention		Milk, fresh grass, Yellow maize Fish and cold liver oil
B	Helps in metabolism of proteins, carbohydrates and fats. Micro organisms help ruminants synthesise vitamin in rumen		Green vegetables g/nuts meal cereals fish meal
C	Importance for disease resistance		Green leafy vegetables Fruits
D	Essential for bone formation. Prevents rickets in animals		Sun light , hay Fish liver oil. Green grass Yeast
E	Essential for proper functioning of the reproductive system Prevents sterility in animals		Cereal grains Soya beans. Grass

		g/nuts oil
K	Essential for blood clotting and prevents bleeding. Maintains shape of the body	Succulent roughages Leafy vegetables
Water	Essential for body fluids. Helps transport nutrients	Drinking water

Feed Rations

- A feeding ration is an amount of feed that contains all feed nutrients.

Types of Rations

i. Maintenance Rations

- A maintenance ration is an amount of feed that the animal needs per day to maintain its body processes without gaining or losing weight.
- Young growing animals and those on gestation need maintenance rations.

ii. Production Rations

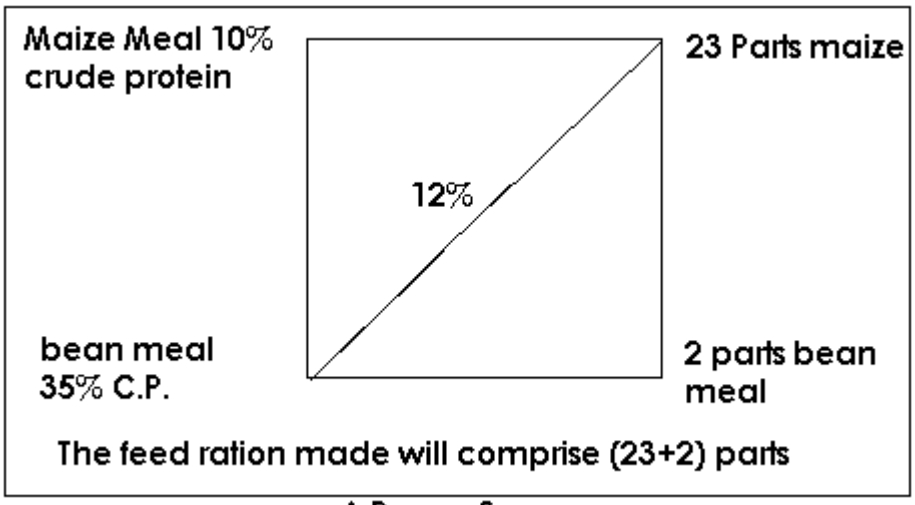
- Production ration on the other hand is an amount of feed that contains all the essential nutrients in right proportions given over and above maintenance ration in order for the animals to produce e.g. layers marsh.

Importance of Feeding Animals

- For the animals to maintain their body weight
- For the animals to produce.

Formulating Feeding Rations

- In order to solve the problem of relaying on manufactured feeds which are expensive, a farmer can make own feed rations which contain all the nutrients
- A Pearson Square method is used to collect a balanced feed ration.
- For example, Formulate a 12% protein feed using maize containing about 10%protein and bean meal containing 35%.



A Person Square

- Place the percentage of each feed to be mixed at the left corner of the square.
- Subtract the figures diagonally across the square.
- Disregard negative signs.
- Place the numbers obtained on the right corners giving the required parts for each feed stuff.

Note: The proportion of the parts of the feeds can be used to calculate any amount of feed ration that you need.

Factors to consider when Feeding Animals

1. Age and size of the animal.

- Young animals require less feed
- Young animals require feeds rich in proteins for them to grow

2. The type of animals.

- Ruminant animals can digest roughages
- Exotic animals require good quality feed for high yield of products.

3. The purpose for feeding the animals

- Drought animals require high –energy feeds
- Milking, meat and eggs animals require more concentrates

4. The condition of the animal.

- Feed should not be wasted on animals already in good conditions but on the other hand animals should not be starved.

5. The quality of the feed

- Give animals feed which are easily digestible and ingestible.

6. Palatability of the feeds

- Give the animals the feeds that have good taste and smell to give animals appetite.

7. The amount of the feed.

- The amount of the feed should depend on its quality and type.

8. Texture of the feeds

- Ruminant animals and chickens prefer feed of course texture while none ruminant animals prefer fine textured feeds.

TOPIC 2: LIVESTOCK MANAGEMENT AND PRODUCTION SYSTEMS

1. SHEEP PRODUCTION (Small Ruminant Animal)

Importance of Sheep

- Provides meat for proteins
- Provides milk especially goats
- Provide skins
- Source of income
- Provides valuable manure for vegetable and field crop production

Breeds of sheep

Both sheep and goats have indigenous and exotic breeds

Sheep

- Malawian fat tailed sheep
- Black head Persian
- Merino
- Karakul
- Desert Ram

Breeds of sheep and their functions

Exotic Breeds	Use
• Black head Persian	mutton
• Dorper	mutton
• Merino	wool
• Karakul	skin (pelt)

Merino Sheep

Ways of selecting breeds of sheep for breeding

1. Primary use of the animal or its product

- Select a breed that gives highest production of mutton, wool or skin
- To improve production of mutton and skin production it is advisable to cross breed the Malawian sheep with the breeds such as Doiset Ram.

2. Adaptation to the climate and local environmental conditions.

- Select breeds that adapt to the local conditions e.g. local Malawian sheep adapt to hot conditions because it is hardly.
- Black Persian and Karakul adapt to desert condition while the Merino adopt to dry condition.
- Hemp shire Down adapt poor pasture.

Management practices of sheep

1. Breeding

- Breeds kept for breeding should be those young animals that have a history of rearing health lambs
- Select ewes that give birth to best lambs during the previous year
- Ewes should be served with a male sheep when they are 18-24 months old white the male animals is at about 8 months old.
- Allow mate sheep move with ewes only during mating period to avoid inbreeding
- Unwanted male animals should be castrated and fattened
- One ram can be served to about 60 ewes however 1:10 – 20 ewes are recommended ratio.

Reasons for castrating rams

- To fatten them quickly so that they can produce more meat
- To avoid in breeding
- To make the male animal docile so that it becomes easy to handle.

Methods of castration animals

1. Using a burdizzo

- This is an instrument like a plier which crushes the spermatic cords above the testicles and this prevents the development of testicles.
- This should be done when the animal is 2-3 months old.

2. Using sharp knife

- This is used to cut the scrotum then the testicles are removed
- The cut is treated with disinfectant to prevent infection

3. Using strong rubber band

- The rubber band is placed above the testicles to cut off the blood flow to the testicles.
- The scrotum and the testicles drop off after a few weeks
- The method is effective when the animal is not more than one week old.

Flushing

- This is the process of giving concentrates to ewes in older to improve their health and fertility before they are mated.

Gestation Period

- This lasts for 150 days in sheep
- During this period the sheep should
  - Be drenched against internal parasites
  - Be vaccinated against diseases
  - Be given quality pasture i.e. hay and silage
  - Be given concentrates one to two months before lambing (steaming up)

Partulation in sheep

Signs of partulation

- The ewe is restless
- The animals leaves the rest for a quieter place
- There is frequent bleating
- The vulva becomes red.

Lambing and caring for lambs

- Lambs should be born when pasture is abundant
- Young ones should be allowed to suckle colostrums and continue sucking their mothers for six months
- Lambs should be given supplementary feed when the yield of milk starts to decline.
- Vaccinate and drench the animals against diseases and parasites respectively.
- Castrate the lambs 1- 2 months and fatten them.
- Slaughter the fattened lambs after six months
- Docking and trimming (cutting of the tail and of grown hooves respectively) should be done before the lambs are too red.

Reasons for Docking

- Prevents dirt and they from collecting under the tail which can be a source of infection
- Helps to parasite control
- Helps to improve the quality of meat
- It helps the animals to mate easily

Housing Sheep

- Housing for sheep should be
  1. strongly built to prevent predators
  2. specially dry and worm
  3. easy to clean
  4. easy and cheap to construct
  5. well ventilated and well-lit.

Feeding in sheep

- As ruminant animals, sheep depend on pasture or grass

- Sheep should also be given up and flushed up
- Crop feeding should be encouraged to improve growth of lamb
- This is a practice of giving lambs extra food in places which are inaccessible to ewes.
- Wean lambs after four weeks.

Diseases and parasites control

- Drenching and vaccinating are the main ways of controlling parasites and diseases respectively.

Parasites of Sheep

1. **Ticks**
   - These suck blood and transmit tick-borne diseases i.e heart water and red water.
   - It can be controlled by regular dipping

2. **Scaly Mites**
   - It causes itching
   - It can controlling by dipping

3. **Lice**
   - It sucks blood
   - It can be controlled by dipping

4. **Round Worms**
   - It causes pot belly in animals
   - It can be controlled by rotational grazing and drenching animals with phenothiazine.

5. **Liver Flukes**
   - It attacks the liver
   - It can be controlled by killing with copper sulphate
   - Avoid grazing animals in wet dambos.

6. **Tape Worms**
   - They attack muscles, lungs, livers, brains and intestines
   - It can be controlled by rotational grazing and drenching animals.

Diseases of Sheep

1. **Pneumonia**
   - It is caused bacteria as well viruses
   - It is identified by loss of appetite, coughing, difficulty in breathing and naval discharges It can be controlled

   - Trenching animals with antibiosis
   - Keep animals in well ventilated, warm and clean homes
   - Giving animals palatable feed and plenty water

2. **Pulp Kidney / Enterotoxaemia**
   - It is caused by bacteria
   - It is identified by tiredness, convulsion, staring eyes, sudden death in severe cases
   - This disease can be controlled by vaccinating the animals.

3. **Heart Water**
   - It is caused by bacteria but transmitted by ticks
   - The signs include loss of appetite, high fever, nervousness, animal walking in cycles, twitching the eyes, high mortality in exotic breeds.
   - It can be controlled by dipping animals
   - Treating animals with tetracycline at early stage.

4. **Brucellosis**
   - It is caused by bacteria and it is identified by dipping of foetus, abortion and uterus infection
   - This disease can be controlled by slaughtering and burning of infected animals
   - Vaccinating of infected animals.

5. **Foot Rot**
   - It is caused by fungi and bacteria
   - It is identified by swelling of feet difficulty in walking, pus from the feet with bad smell, lameness.
   - The disease can be controlled by trimming hoses and disinfected the feet.

6. **Foot and Mouth**
   - It is caused by virus
   - The animals has high fever has blisters which makes difficult to graze
   - There is excessive salivation and lameness
   - This disease can be prevented by restricting movement, vaccination of animals, slaughtering and turning of all infected animals.
7. **Mastitis**
   - Caused by bacteria
   - It is identified by swollen udder
   - Clots of milk in blood and pus is found in the milk
   - The disease can be treated with antibiotics, cleanliness and hygiene during milking vaccinate and animals and use disinfectants.

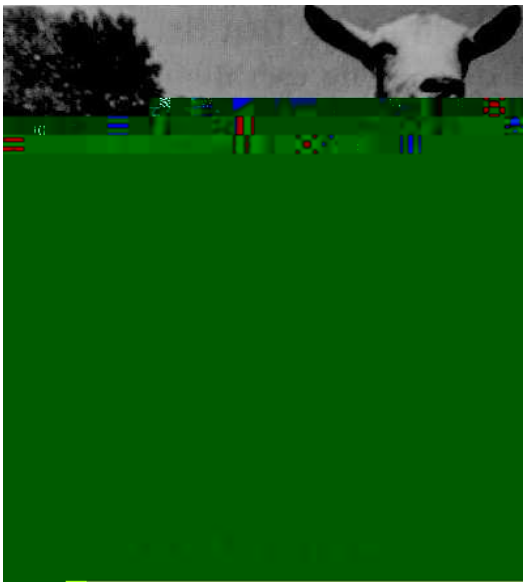
8. **Sheep Pox**
   - It is caused by virus
   - The animals has high fever, dark red pimples
   - Dying of some lambs in severe caves

2. GOAT MANAGEMENT

- The management practices for goats are not any different from those of sheep

Breeds of Goats

- Malawian goat
- Small east African goat
- Angola
- British saanen
- British Alpine
- Toggenburg
- Boer goat



Boer goat

Different breeds of goats based on functions

• Angola goat	mohair
• British saanen	milk
• Anglo- Namibian goat	milk

System of managing goats

1. **Tethering**
   - In tethering animals are allowed to graze on a restricted area because they are had to a rope
   - This is done where there is limited grazing land and also to protect crops

2. **Extensive system**
   - Under extensive system of management goats are allowed to graze or browse natural pastures, trees, pastures and shrubs.
   - Goats can also be kept under semi- intensive and intensive system
   - In semi- intensive there is controlled grazing and stall feeding
   - With intensive system goats are kept in a house where forage and concentrates are given to them
   - Apart from concentrates goats are given salt licks and clean water
   - Intensive system is mostly used for exotic goats kept for milk and meat production e.g. Britain saanen, Anglo-Nubian, goat, beer goat, British Alpine and Toggenburg

Methods of selecting goats for breeding are similar as in sheep management

Goats kept for meat production should

- grow fast and mature early
- be from nannies with good mothering habits
- have a good body shape

But those selected for milk production

- Should have well developed udder.
- You may be aware that
  1. Suitability of a breed to the local and economic environment
  2. personal preference are criteria for selecting goats for breeding

Breeding

- Nannies should be served 15 – 18 months with the billies
- One billy goat can serve 60 nannies but the recommended ratio of nannies to billy is 25-30 nannies
- The remaining billies are castrated just in the same way as in sheep.

Oestrus cycle

- The oestrus cycle for goats lasts for 18 – 21 days
- The sign for heat period in nannies is the same as in sheep
- Mate the animals five months before rain season in order for the kid to be born when there is plenty pasture

Gestation period in goats

- Gestation period in goats lasts for 150 days
- Nannies can therefore give birth twice a year
- The process of giving birth in goats is known as kidding
- Goats sometimes give birth to twins.

Signs of kidding in goats

- Udder swell
- The animal is restless and nervous
- The animal bleats
- There is discharge from the vulva

Care for kids

- Let the kid suckle colostrums 3-4 days to get immunity
- Kids should be weaned when they are 3 – 6 months old
- Hygiene should be observed when the kid is bucket fed to avoid infection and diarrhoea
- The milk should be warm of room temperature when fed to kids

- Kids are introduced to pasture after 3 weeks after birth in order for them to develop their digestive system
- Male kids should be castrated 3 weeks after birth.

Housing for goats

- Goats housing is the same as that of sheep

Feeding of goats

- Goats are browsers than grazers
- They like tree barks, leaves, schools or twigs, shrubs and herbs
- Goats can cause desertification if not well controlled
- For high quality meat or milk goats should be supplemented with concentrates for energy for example maize meal, madeya, rice hulls, groundnuts, cotton cake, cow peas and pigeon peas as protection concentrates.
- Roughages and fresh clean water

Pest and disease control

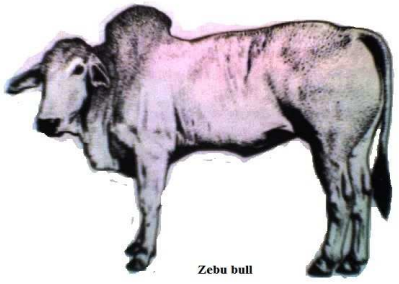
- Goats are disease resistant however they act as carriers of internal and external parasites for other animals as such they need to be dipped, dusted and drenched to control fleas, lice, ticks and tsetse flies, tapeworms, round worms and liver flukes.
- Goats are also attacked by the same diseases that attach sheep and they should therefore be controlled in the similar way (refer to the disease that attack sheep)

TOPIC3: BEEF PRODUCTION

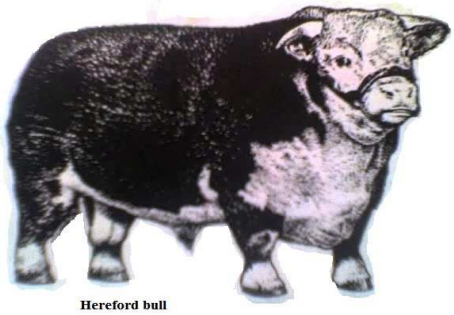
- In order to produce meat of good quality and large amount of animals of local or indigenous type should be cross bred with exotic breeds. Exotic breeds should also be cross bled and be able to withstand hostile or harsh tropical condition

Examples of beef breeds

• Malawi Zebu	Malawi
• Africander	South Africa
• Hereford	UK
• Buran	Kenya
• Brahaman	India
• Chorolais	France
• Simmental	Switzland
• Shorthon	UK
• Abeden angus	UK



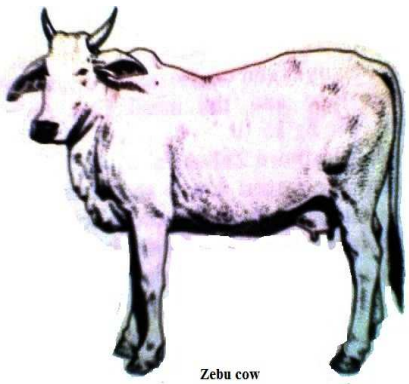
Zebu bull



Hereford bull

Aberdeen Angus bull

Boran bull



Zebu cow

Characteristics of beef breeds

- Rectangular or square in shape

- They have deep and compact body
- Short legs
- They grow fast and mature quickly
- They have heavy and flesh bodies
- They are foragers, efficient in converting pastures into high quality beef.

Management of beef cattle

- In order to have beef of good quality the following management practices have to be done
  1. feeding
  2. housing
  3. breeding
  4. pest and disease control
  5. marketing

1. Feeding

- Feeding of beef animals is done through the following systems
  - i. extensive system
  - ii. intensive system

i. Extensive System

- Under this system animals are fed through communal grazing and ranching
- The land in which they graze is owned by everyone

A. Communal Grazing

Advantages

- It is cheap

Disadvantages

- Difficult for animals to gain weight quickly they spend much of their energy for moving
- Easy to contract disease
- They cause over grazing which lead to soil erosion

B. Ranching

- Animals are kept in extensive paddocks and allowed to graze freely
- This paddocks are owned by an individual or the government

Advantages

- Animals have plenty of pasture
- Animals can gain weight quickly as compared to communal grazing because extra feed and water are provided to them

Disadvantages

- Requires a lot of land
- Animals take along time to gain weight because they move too much as compared to intensive system
- Spread of pest and disease is easily
- It is expensive because extra feed and water are provide to the animals

Examples of ranching in Malawi

- Dzalanyama in Lilongwe
- Kuti in Salima
- Chikwawa cattle ranch in Chikwawa
- Nsanje cattle ranch in ranch

ii. Intensive System

- In this system animals are kept in smaller paddock or (khola)
- Rotation grazing and cut and carry method are practiced in intensive system
- This system is also known as well feeding

Advantages of Intensive

- Animals gain weight quickly
- Pest and diseases are easily controlled

Disadvantages

- They are expensive
- Labour intensive (requires a lot of labour)

2. Housing

- Animals should be kept in a well ventilated (khola)
- The (khola) should be well thatched and leak roof
- Should be constructed at a raised ground which is well drained
- The (khola) should be special and each animal should have a space of 2.0 metres x 2.0 m x 2.4 metres high

3. Breeding

- For more beef production across bred Malawi zebu should be used for breeding
- Bulls and heifers which are mature enough should be used for breeding
- A bull at 18 month and heifers at 2 years in the ration of 1:20 or 30 should be taken for breeding
- Calving should be done two months before a season so that the calves should get enough grass
- Calves should be kept in separate pens might and weans then after six months.

Caring for Calves

1. Castration

- This is the removal of testis in order to
    i. prevent breeding
    ii. make the animal docile
    iii. fatten the animal quickly
    iv. improve the quality of meat
- The testis are removed by a knife or elastic band
- A burdizzo is used to crash the spermatic
- Castration should be done at 6 months just before weaning

2. **Disbudding**
   - This is the process of stopping the growth of born buds because they are easy to handle
   - Prevent the animals from hurting each other or people
   - Disbudding is done by the use of caustic soda or to minimize the pain anaesthetic is used also.

3. **Dehorning**
   - Removal horns from cattle to prevent animal from hurting each other or people who care for them
   - Dehorning is done by a hot dehorning horn as sometime a saw

4. **Branding**
   - This process of placing an identification mark number of easy identification by using a hot branding horn or cold frozen.

Pest and Disease Control in Beef Breed

- There are different pest and disease that affect beef breeds.

Diseases

1. **Red Water**
   - It is caused by protozoa and spread by blue tick
   - It is characterized by high temperature and red urine

The diseases can be controlled by

- dipping cattle to control the ticks.
- controlling movement of cattle
- vaccinating all suspected animals
- treating animals with suitable drugs

2. **East Coast Fever (ECF)**
   - It is caused by protozoa and transmitted by brownear tick and red tic

The signs of ECF include

- High temperature
- Loss of appetite
- Excessive salivation
- Diarrhoea

The disease (ECF) can be controlled by

- Quarantine the animals in case of cut breath
- Dipping animals to control ticks
- Has no treatment

3. **Gall Sickness**
   - Caused by bacteria and spread by blue tick

   The signs include

   - High temperature
   - Lack of appetite
   - Pale mucus membrane
   - Staring coat
   - Death

   Can be controlled by

   - Dipping cattle and tetracycline.

4. **Heart Water**
   - Caused by bacteria and spread by bunt

   Its signs include

   - High temperature
   - Convulsions or fits
   - Deaths

   It can be controlled by

   - Dipping animals
   - Vaccinating suspected animals

5. **Foot and Mouth Disease**
   - It is caused by virus

   Signs

   - High fever
   - Blindness on the tongue, skin in the mouth
   - Lameness
   - Difficult in eating

   Can be controlled by

   - vaccinating all other animals
   - slaughter and bury all infected animals
   - has no treatment

6. **Cattle Plague (Rinderpest)**
   - It is caused by virus

Signs

- High fever and red urine
- Sore in the mouth and nostrils
- Excessive salivation
- Diarrhoea
- Blood stained faeces

Can be controlled by

- vaccinating animals every six months
- quarantine all affected
- slaughter affected animals

7. Mastitis

- It is caused by bacteria and spread through teat canal

The signs of mastitis include

- high fever
- blood/ pus stained milk
- swollen udder and teats

The disease can be treated by

- Antibodies e.g. penicillin and tetracycline.
- Practicing hygiene milking like washing hands with warm water

8. Tuberculosis (TB)

- It is caused by bacteria and spread through contact with other infected animals

The disease is characterized by

- fluctuation of temperature
- loss of weight, diarrhoea
- persistent coughing
- thick white vagina discharge
- sterility in animals

The control of tuberculosis

- slaughter infected animals
- Vaccinate animals with BCG vaccination
- Treat animals with tuberculin.

9. Black Quarter

- It is also caused by bacteria and spread through ingestion of sores
- These sign of the disease include high fever, loss of appetite, lameness

10. Anthrax Diseases

- It is caused by bacteria and spread through ingestion or inhalation of bacterium

This disease is characterized by the following signs

- Sudden death of animals
- Enlarged spleen
- Blood discharge from anus and nostrils

The disease can be controlled

- Destruction and burying all dead animals
- Vaccinate remaining animals

11. Brucellosis

- This is caused by bacteria and spread through contact

The sign include

- Abortion
- Genital inflammation in cows and swollen testicles in bulls

Treatment of diseases is through

- slaughtering infected animals
- vaccinating remaining stocks

12. Trypanosomiasis

- It is caused by protozoa and spread by tsetse flies

Signs

- Frequent fever
- Dullness of animals
- The animals become anaemic
- Death may occur in severe attack

Control of Trypanosomiasis include

- spraying the areas with tsetse flies
- slaughter body infected animals
- drench the animals with berenil drug

Parasites of Cattle

- There are two groups
  - External parasite e.g. Tick, tsetse flies
  - Internal parasite e.g. Tape worm, Round worm, Liver flukes

External Parasites

Effects of External Parasites

- They suck animal blood and cause them anaemic
- They damage the skin of the animal
- They make the animal weak
- They transmit diseases to animals e.g ticks transmit
  - East coast fever
  - Red water disease
  - Gall sickness
  - Tsetse flies
  - Trypanosomiasis
- They affect animal production

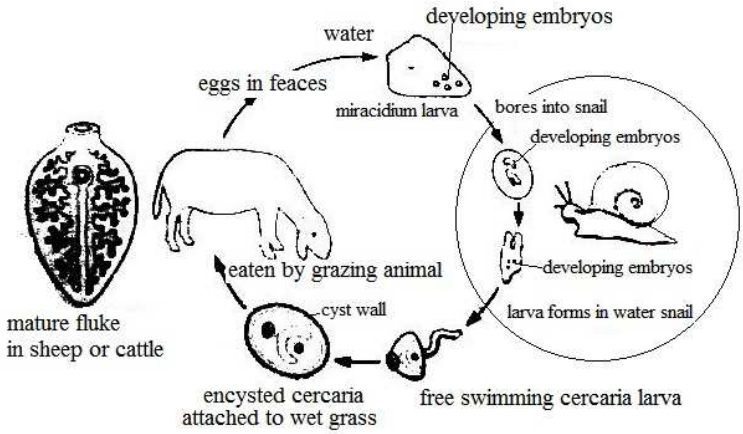
Control of external Parasite

- Dipping animals
- Spraying animals and infected pasture
- Practicing rotational grazing

- Use cut and carry methods

Internal Parasites

- The main ones are roundworms, tapeworms and liver flukes.
- Animals get infested with these through grazing.



Life cycle of the liver fluke, *Fasciola hepatica*

Parasite	Damage caused / Sign of attack	Control method
Roundworms	• Attack the intestine • Absorb digested food from animals	• Deworming by drenching animals with Phenothiazine

	. , E & - . (, -	. / & .
'	. $ $. ' $ & & . %	. / .)
" $	. % $. / & . % & $. % &	.) (. / & . /

3! ((

. ' + &
$
· + O & $
·)

& ' &% .

-) & &
-) &
-)

) & '

. ' &
· &
.
.

$ ('0 &

- 2 4000 $ *
- N 8:00 $
- 9 :400 $
- 8000 $

") 1 &

+)
. ' $

-# % " & +
· ! $
·

2#)) .
> & $
$
. * & $ $

3#)) .
. * $ $ & $
> >

4# ,)
. ' > $

- Planning, mating to allow calving take place when pasture is much available enables cows to produce more milk.

6. Period of Lactation

- The cow dries off after 305 days (10 months) of lactation
- Yield of milk increases during the period of mating 2-3 months after calving

7. Milking Frequency

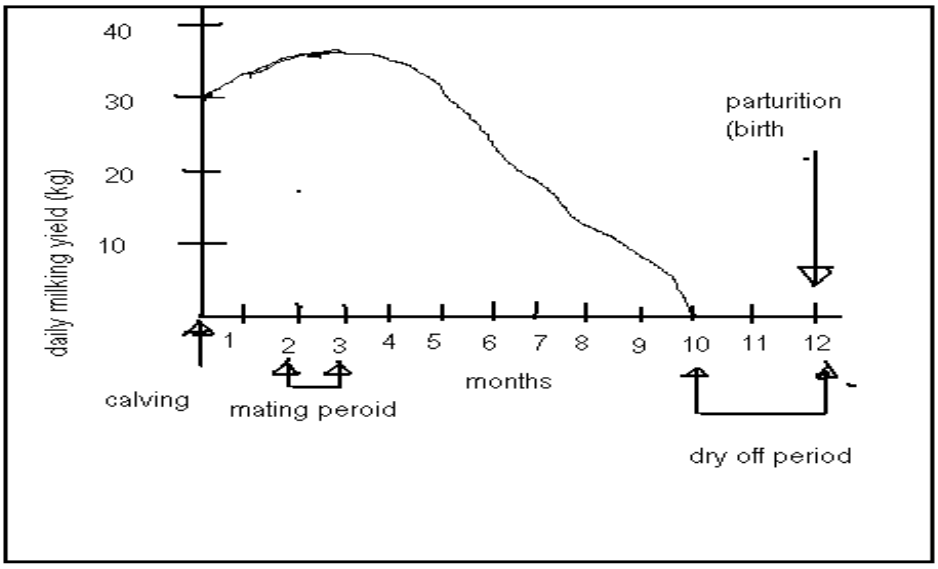
- Over milking or under milking looses yield of milk
- Milking should be done twice a day

8. Treatment of the Cow

- Lactation animals that are harshly treated produce low yield of milk

9. Milking Techniques

- Milking by hand or machines
- Over milking and under lowers yield

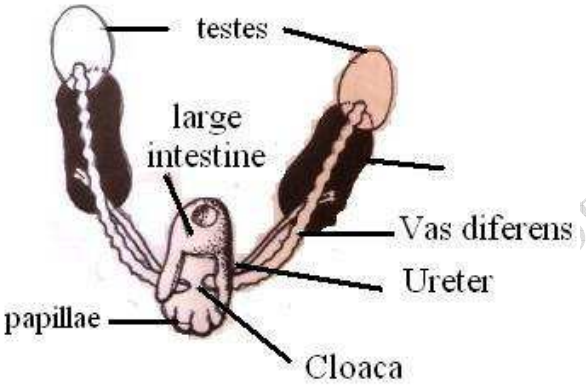


Line graph showing lactation curve

TOPIC 5: ANATOMY AND PHYSIOLOGY OF THE REPRODUCTIVE SYSTEMS OF POULTRY AND CATTLE

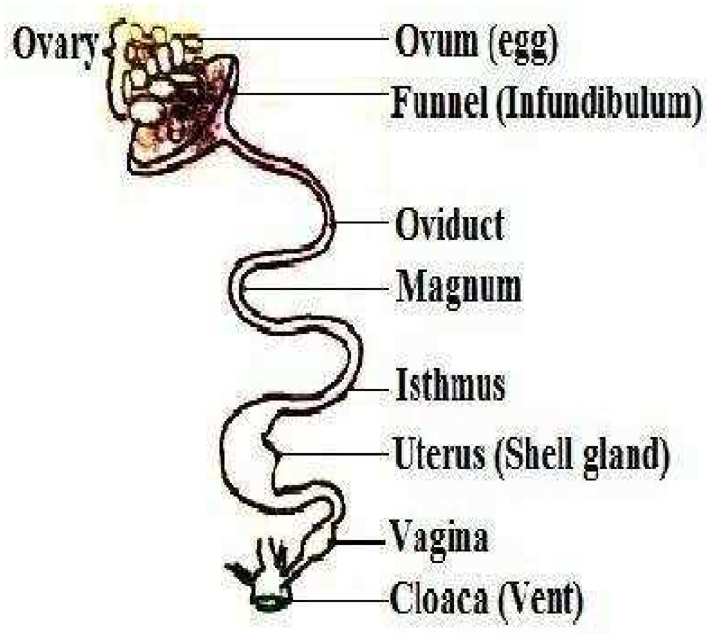
- In order to know how to breed livestock successfully, it is important to know about the anatomy and physiology of the reproductive system

Reproductive System of Poultry



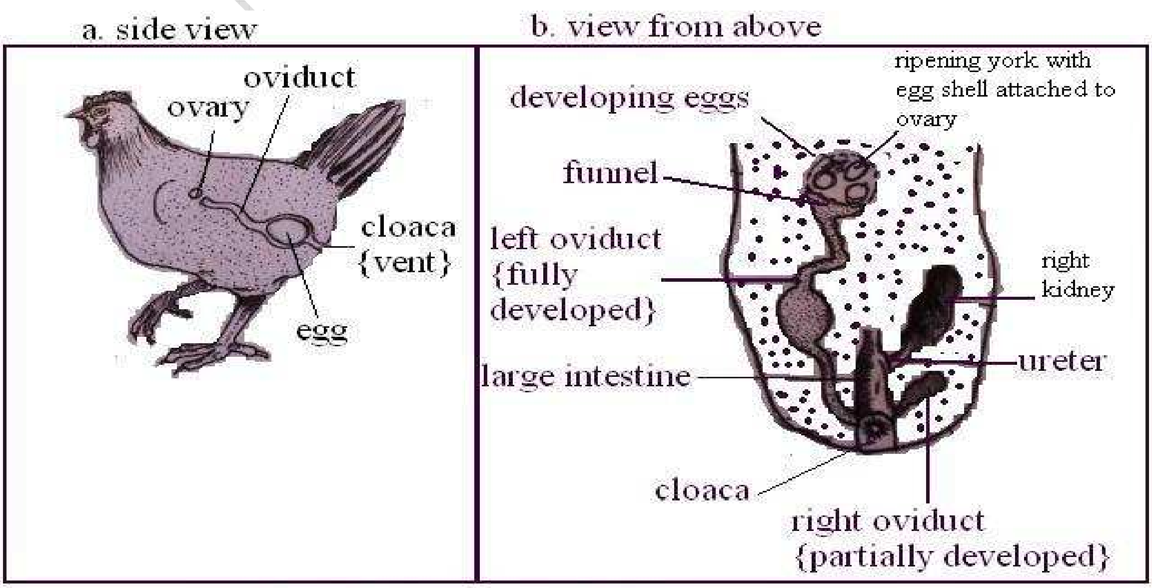
the reproductive system of a cock

- A cock has two testicles lying high in the abdomen cavity each connected to the cloaca by the sperm duct.
- The papillae are copulating organs of a cock.
- When a cock mates with a hen it presses its cloaca against that of a hen to introduce sperms.



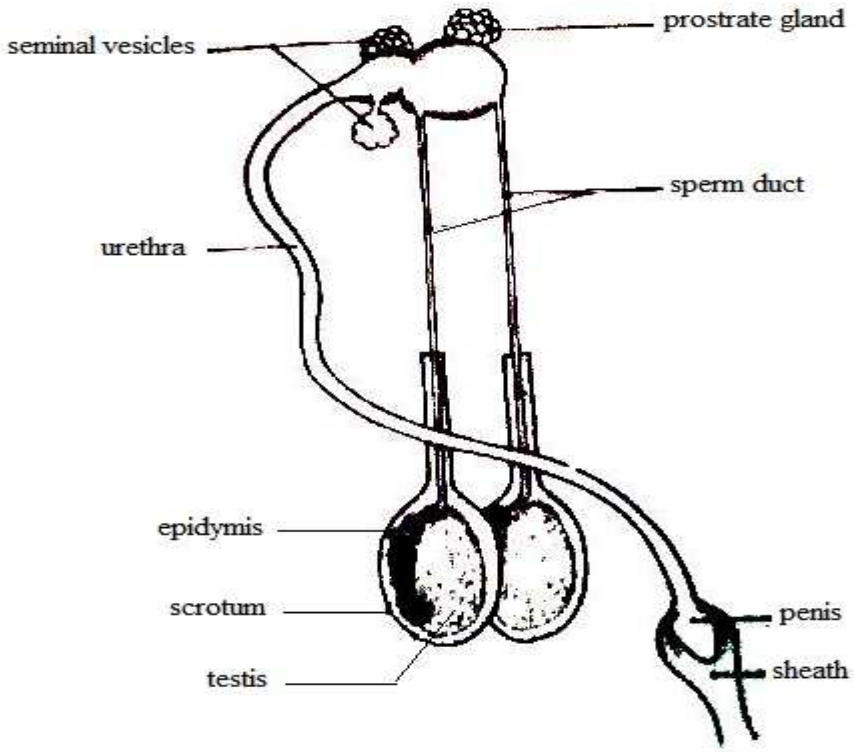
Reproductive System of a Hen

- The **oviduct** is a long tube consisting of the infundibulum, magnum, isthmus, uterus, vagina and cloaca.
- The **egg** is formed both in the ovary and the oviduct.
- When a hen matures some of the ova develop into mature York inside a productive follicle.
- When the York is released from the follicle, it goes to the **infundibulum**.fertilization of an egg is done in the infundibulum because this is where sperms from a cock are stored.
- **Magnum** is also a part within the oviduct where albumen of an egg is added.
- **Isthmus** is below the magnum where mineral salts, water, and shell membrane get added to the egg. From the isthmus the egg goes and stays in the uterus foe 18-21 hours
- **Uterus** is where egg shell is added to the egg.
- It takes 24 hours from ovulation in the ovary to the laying of an egg.
- The pores are sealed in the vagina.
- The egg is laid through the cloaca (vent) from the vagina.



Repruductive system of a hen

Reproductive System of Cattle



The reproductive system of a bull

Functions of the parts of male reproductive organs

i. **Testicles**
- These are two oval shaped testis contained in a sac (scrotum) suspended between the hind legs because the sperm that are produced at slightly lower temperature than that of the body

ii. **Epididymis**
- They store the sperms produced by the testicles

iii. **Sperm Ducts**
- These are also known as vas differentia or vas deferens and there function to carry the sperms from the testicles to the seminal vesicles.

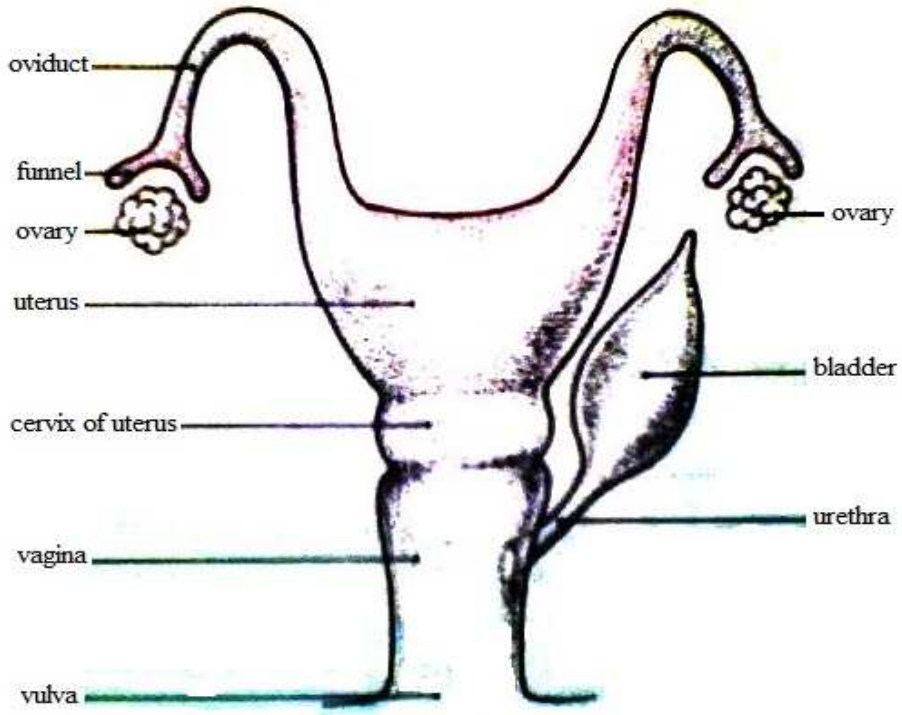
iv. **Accessory Glands**
- These comprise the prostate gland, cow per's gland and the seminal vesicles.
- The glands produce sticky fluid called semen which carries the sperm

v. **Urethra**

- This is a tube that leads from the bladder through the penis. Its function is to allow urine to leave the body semen which contains sperm also passes through the urethra and penis as it is being introduced into the sperm
- The sperm are released by the bull during the process called ejaculation once released; it swims in the semen and travel up to the fallopian tubes where fertilization of the egg takes place

vi. Penis

- This is an organ of copulation that is used during mating
- It has spongy tissues that get filled with block as the bull mates with the cow
- The penis becomes erect which facilitates easy entry into the vagina of the cow
- The reproductive system of poultry



The reproductive organs of a cow

i. Ovaries

- The main functions are
  - Producing eggs (ova)
  - Responsible for secreting the sex hormone i.e. oestrogen and progesterone

ii. Corpus Luteum

- This prevents the release of other ova after rupturing of the graaffian follicle.

iii. Oviducts

- Assists in the movement of eggs to the uterus

iv. Uterus

- The fertilized egg is implanted in the walls of the uterus (womb) the walls of the uterus enlarge as the embryo grows.

v. Cervix

- Consists of thick muscle and it separates the uterus from the vagina
- It is closed except during oestrus period and the animal is giving birth.

vi. Vagina

- Receives the bulls penis during the process of coition
- It also serves as the birth canal and passage of urine from the bladder.

Reproductive Process in Cattle

- Cattle are viviparous animals which give birth to the young ones.
- This is possible when a male and female animal mate
- Mating process allows the release of sperm by the male which are fused with the eggs resulting into fertilization
- Reproduction in this case takes place when the mate and female animals reach puberty (sexual maturity)
- When a male animal reaches puberty sperm are produce while a female begin to develop ova, heat period set in and ovulation occurs
- The development of uterus starts at puberty with the influence of hormones.
  - Males – testostrogen
  - Female – oestrogen
- Male animals (cattle) reach puberty at 8 months while female animals reach puberty at 9 months.
- Sheep and goats at 5-6 months
- Rabbits take 6-7 months

Factors affecting rate of animals to reach puberty environmental factors

i. Unfavourable climate conditions

- e.g. drought delays puberty

ii. General management especially feeding

- Calves that are properly feed and well looked after reach puberty earlier.

iii. Type and breed of animals

- Some animals mature quickly than others

iv. Mating

- It may also influence maturity to be hastened

Oestrus

- This term means Heat period when female animals show desire to mate. The ova develop and the oviduct is made ready to receive the ova.

Signs of Heat Period

- The cow becomes restless
- There is frequent moving (bellowing) of the cow.
- It mounts other animals and stands still when mounted
- The vulva becomes reddened and enlarged
- Mucus discharge from the vulva
- Increase in urination
- Milk production declines in lactating cows.

Oestrus cycle

- The Oestrus cycle is the interval between one heat period and the next which has four phases

Phases of the oestrus cycle

1. **Proestrus Phase**
   - Lasts up to three days and the reproductive trod is prepared muscles of the ovary grow and vagina walls thicken due to influence of oestrogen

2. **Oestrus**
   - This is the stage when the animal has a strong sexual desire and shows the signs of heat
   - The follicles continue to grow to maturity.

3. **Metoestrus**
   - The period when corpus luteum is formed and the body secretes progesterone which suppresses the growth of the follicles so that no more eggs are released.

4. **Diostrus**

   - At this stage the corpus luteum is retained if fertilization has taken place and the animal is pregnant.

a. Fertilization

- This takes place when the male fuses with the female gametes
- The fertilized egg forms a zygote which travels down to the oviduct and attackes itself to the uterus wall.
- This takes 15 days in cow and 30 days in ewe
- Rapid cell division takes place for a zygote to form an embryo then a foetus.
- The unfertilized sperms take 20 to 30 hours in the female track before dying

b. Foetus Development

- When an embryo develops into a foetus, the heart first develops followed by the circulatory system.
- The foetus attaches to the uterus by developing a placenta through the umbilical cord.
- Blood vessels in the placenta lie close to the blood vessels in the uterus so that the foetus is able to get the oxygen and nutrients through the blood system but there is no direct connection between the foetus's blood system and mother's blood system.

- The foetus is surrounded by three fluid-filled membranes which apart from providing warmth, it also lubricates the birth canal during birth.
- The foetus gets nutrients from the mother through diffusion which is made possible by the duodenum of the two circulatory systems.

c. Respiration

- Oxygen gets the blood system from the placenta through diffusion.

d. Excretion

- This is also down through diffusion from the foetus to the blood stream of the mother.

e. Gestation

- This is the period from the time of fertilization to birth
- Gestation period in cow take 283 days while in nanny 150 days , ewe, 150, so 115 days and rabbit 31 days.

f. Parturition

- This is the process of giving birth to young ones in an animal after 9 months of pregnancy.

Sign of Parturition

- Cow becomes restless
- The udder becomes large
- Mucus is change from the vagina
- Relaxing of ligament muscle

TOPIC 6: LIVESTOCK IMPROVEMENT

- Livestock improvement refers to the attempt to improve the genetic makeup of livestock and the environment in which they are kept in order to increase production
- The potential of an animal to produce is largely determined by the genes that it inherits from its parents.
- Apart from genetic influence, environment also plays a larger role in improving production
- The environment that offers proper housing, feeding as well as pest and disease control helps to improve livestock production.

Aims of livestock improvement

- To increase yield of products e.g. milk, meat, eggs
- To improve the quality of animal products
- To increase disease resistance in animals
- To improve the rate of growth (shorter time to maturity)
- To breed animals which are resistant to climatic conditions.

Methods of livestock improvement

- Basically there are three main methods
    a. Selection
    b. Breeding
    c. Introduction

A. Selection

- This is the process of choosing animals with desirable characteristics for breeding based on their phenotype and genotype (appearance and genetic characteristics respectively)
- Male animals are selected based on performances of offspring and this is known as progeny testing while selection of female animals is based on egg and milk characteristics and it is known as Sib selection.

1. Artificial Selection

- This is the selection of animals by farmers based on their desirable characteristics or good qualities
- If artificial selection is done continuously, it helps farmers to fix the desirable characteristics in the animals that will result into the animal's adaptations to the environment and improved production.

2. Natural Selection

- The process of choosing animals that look more suited to the environment in which they live for breeding
- The principle of survival of the fittest is applied here

Characteristics of animals to be selected for breeding

- Select chickens that have high rate of egg production and good size of eggs produced

- Hens of good breeding habit
- Select cows that have good mothering habit
- Good milk producer
- Gives birth to live young ones
- Ability to suckle young one
- Choose animals that grow faster
- Choose animals with low infant mortality
- Choose the animal with high fertility
- Choose the animals that produces milk of high quality and quantity
- Choose animals that convert pastures to high quality products such as milk and meat
- Choose animals with high resistance to disease
- Choose strong and healthy looking animals
- Choose animals that have ability to work (oxen)
- Choose animals that are docile (easy to control)

B. Breeding

- There are three types of breeding systems
    1. Inbreeding
    2. Out breeding
    3. Artificial insemination

1. Inbreeding

- This involves the mating of closely related animals e.g mother and son, father and daughter, brother and sister.

Advantages

- It brings uniformity in the animals
- This is the only way of producing pure breeds

Disadvantages

- Leads to loss of energy and strength in the off springs
- Performance in the off springs is lost because undesirable characteristics are passed on by parents

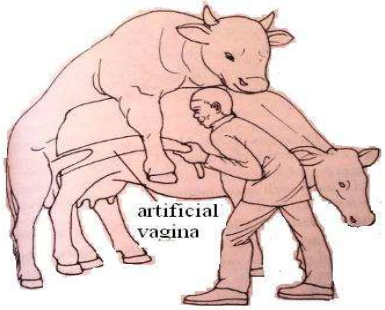
2. Out Breeding

- This refers to the mating of animals that are not closely related.
- The animals mated can be of the same breed out crossing or line crossing or they can be of a different breed (cross breeding)

Advantages

- Introduces new blood in the herd which helps to improve the performance of the off spring
- The performance of the offspring is improved (hybrid vigour) or Heterosis
- The off spring produced give more meat, milk and milk quality e.g. Malawi Zebu x Brahman/ Charolais produces improved bull.
- The cross bred calf will grow fatter than any other

3. **Artificial Insemination**
   - This is the artificial introduction of sperms into a reproductive tract of a female animal without necessary involving mating of male and female animals
   - This exercise is done by veterinary trained personal.



Collecting semen from a bull

Advantages of artificial insemination

- It eliminate the cost of buying and keeping a male animal hence it is cheaper
- It reduces the spread of sexually transmitted disease e.g. brucellosis
- It is possible to store the sperms for some time and use them when required
- Semen from one male animal can be diluted and be used to serve many female animals (up to 200 cows)
- It is easy to keep records and track females which have been served already
- Semen from heavy animals can be used to serve small female animals which would be naturally different.
- It is easy to plan for breeding programme.

Disadvantages of artificial insemination

- It is expensive to set up and maintain A.I programme
- Difficult for A.I administration because it is not easy to detect when cows are on heat
- Collection and administration of A.I requires trained personnel
- Communication problems between farmers and A.I headquarters because of distance and this delays time on serving the animals.
- A.I does not achieve 100% results as the success rate of conception is 80 %

NOTE: A.I is done by research experts from Bvumbwe agriculture station, Chitedze Agriculture Station, Bunda College of Agriculture and other experts from Agriculture headquarters in the department of animal husbandry.

C. Introduction

- The process of bringing the exotic pure bred animals with desirable characteristics into one's country. E.g. Friesian and Jersey from Europe were introduced into Malawi

NOTE: Animals from the temperate areas are not used to tropical conditions and need special care in terms of feeding, housing, pest and disease control

.

UNIT 4: AGRICULTURAL MARKETING

TOPIC 1: MARKET FORCES

- Demand and Supply are the market forces that influence price of commodities on the market.
- Demand is the amount of goods that consumers or buyers are prepared to by at the given price.
- When the price increases on the market supply decreases and when price decreases, demand increases.
- Supply is the amount of goods that sellers are prepared to offer on the market at agiven price.
- When the price of commodity on the market increases the supply of the commodity also increases.

Demand and supply table.

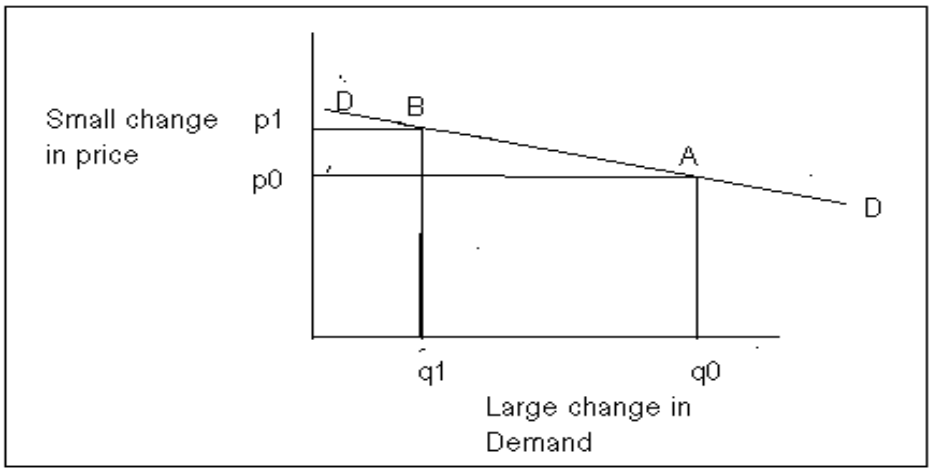
Price(Mk/kg)	Quantity of Goods demanded (kg)	Quantity of Goods Supplied (kg)
90.00	5900	3600
100.00	5600	4300
110.00	4800	4800
120.00	4200	5100
130.00	3700	5800

- In the table above the demanded goods is decreasing as the price is increasing and on the other hand the amount of supplied commodities is increasing with the increase in price.
- At K110/kg the amount of demand and supply is at equilibrium. This is known as Market price.
- People are free however to change the price of commodities depending on different factors.
    - **i. Price of commodity can change because of change in production costs.**
        - When the cost of production has gone up, farmers may adjust the price of their products upwards.
    - **ii. Attraction of customers.**
        - Some producers may wish to decrease the price of their products just to attract more customers so that they can have more customers.
    - **iii. Prices also change because of product modification.**
        - Some farmers increase the price when the quality of their products has been improved.
    - **iv. Competitor's prices.**
        - When competitor's of the same commodity offer higher prices some suppliers are forced to increase the price of their commodities also. Sometimes you are forced to reduce the price when everyone offers lower price than you otherwise you cannot get customers. Sometimes a farmer can reduce the price of their commodity in order to drive the competitors away.

Price Elasticity of Demand

- This is the degree to which demand for a product responds to change in its price.
- It measures how much change will be in demand with respect to any change in the price of commodity.
- Elasticity of demand can be
    i. **Elastic**:
        - Small change in price causes large change in demand. This is more common in luxury commodities which have more substitutes. This implies that many people can still survive

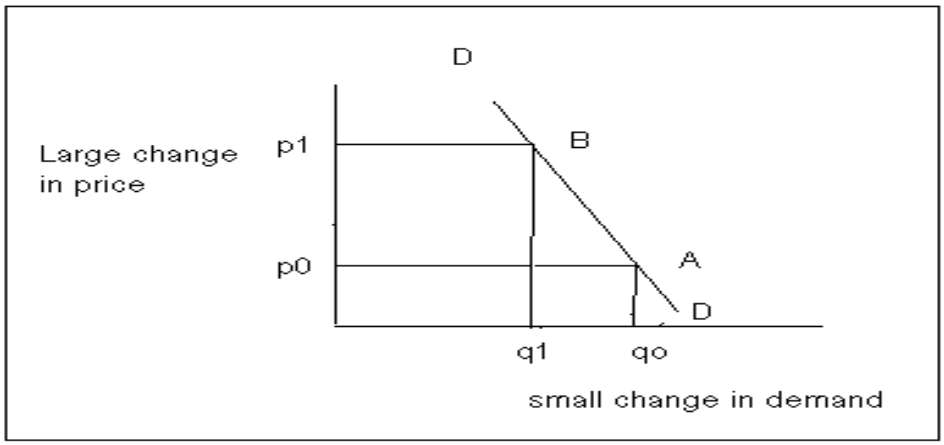
without these commodities. For example beef, oranges, tomatoes, juice, honey, tobacco, eggs etc.



Elastic Demand

ii. Inelastic:

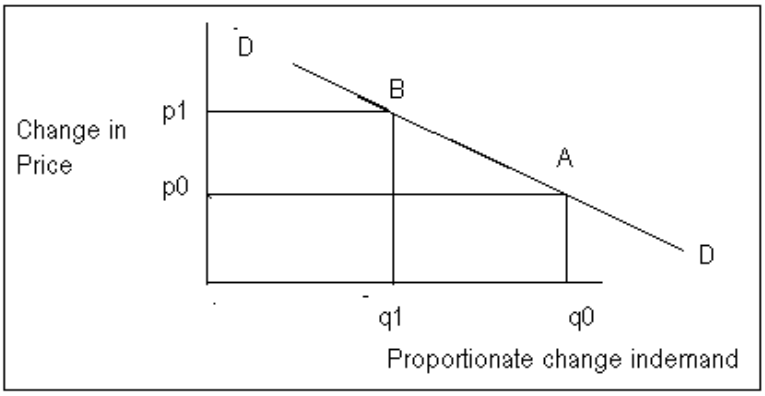
- This occurs when change in the price of products on the market will have little or no response on the demanded goods. A large change in price may only show a small change in the demand for the commodities and this is sometimes negligible. Inelastic elasticity commonly occurs in staple food items or products that do not have substitutes and consumers have no choice but to buy them regardless of the increase in price, e. g. maize in most parts of Malawi, rice along Lake Shore areas and cassava in Nkhotakota. ***Refer below***



Inelastic demand

iii. Unitary:

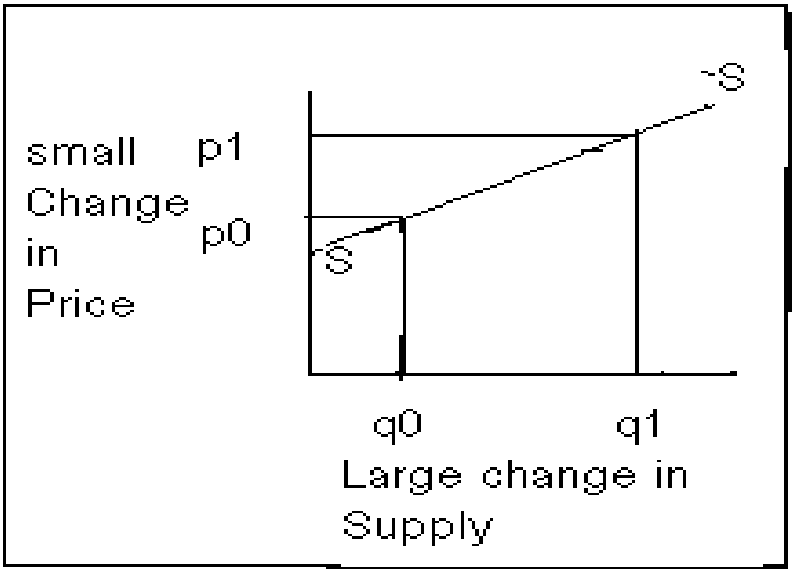
- This signifies that there is proportional change in demand to any change in price of commodities. There is a 1; 1 ratio in the change of price of commodities to change in demand of those commodities. ***Refer below***



Unitary Demand

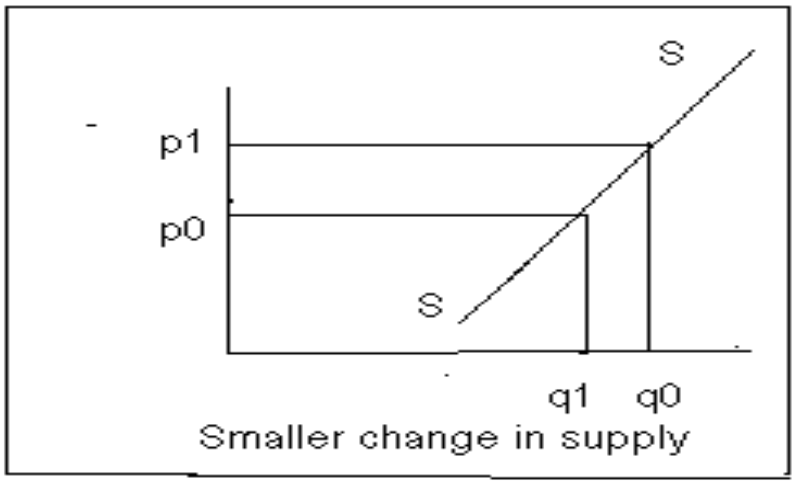
Price Elasticity of Supply

- Price elasticity of supply is the degree to which the supply of a commodity changes because of a change of price of that commodity.
- Just like in Demand, price elasticity of supply can also be described as elastic, Inelastic and Unitary.
  - **Elastic Supply.**
    - Change in the price of commodity results in a larger response for a larger change in the quantity of goods supplied. Supply is very responsive to price changes. The increase of price from p0 to p1 will cause the increase in supply from q0 to q1(refer figure below.



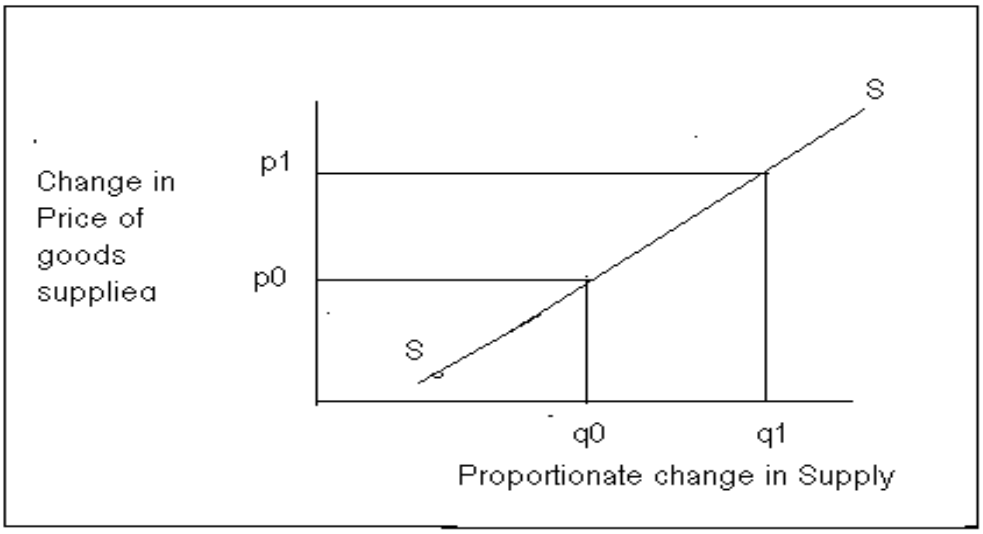
a. Elastic supply

- **Inelastic Supply**
  - This helps to explain that change in the price of the product will cause a small or negligible change in supply of products on the market. Big reduction in price of commodities will cause a small decrease in supply of supply in subsistence products, e.g. maize. ***See figure below.***



b.Inelastic Supply

- **Unitary Supply.**
  - This is a one to one response of goods supplied to a change in price of the commodity.
  - The change is directly proportional as shown in the figure below.



c.Unitary Supply(=1)

Significance of the degree of price elasticity of demand and supply

Degree/category	Significance	Implications
Elastic (>1)	Highly responsive	A small price change cause a large in demand or supply
Inelastic (< 1)	Less responsive	A big price change causes a small change in demand or supply
Unitary (= 1)	One to one response	A change in price causes a proportionate in demand or supply.

Degree of elasticity of demand and supply and their significance-Agriculture Strides Book 3, Page 125.

TOPIC 2: MARKETING CHANNELS AND AGENCIES

1. MARKETING COSTS AND MARGINS

- Marketing costs are expenses incurred by marketing agencies or payments paid to marketing agencies for their services in the marketing channel.
- Sources of marketing costs:
  - Cost of assembling
  - Packaging
  - Storage
  - Transportation
  - Grading
  - Middle man's profit or commission

2. MARKETING MARGINS

- This is the difference between the costs of buying the produce and selling it to consumers.
- Market margin = Retail price – farm gate price.
- Marketing margin = Marketing costs

3. MARKETING CHANNELS

- Farmer level→ Itinerant trader→ Wholesaler→ Retailer.

Marketing Channel Level	**Charges**	**Price**	**% share**
1. Farm level Farm gate Price (Chimbiya)		K900.00	25.00
2. Itinerant Trader Cost of hessian Transport cost to Blantyre Trader's Profit	 K 15.00 K285.00 K600.00		
	K900.00	K1800.00	25.00
3. Wholesaler level (BT) Grading Packaging Wholesale Commission	 K100.00 K150.00 K250.00		
	K600.00	K2400.00	16.67
4. Retailer level (Ndirande) Transport to Ndirande Displaying and Advertising	 K30.00 K240.00		

Storage Retailer's profit	K130.00 K800.00		
	K1200.00	K3600.00	33.33
Price paid by final consumers	-	K3600.00	-

- Marketing agencies have market functions to perform.
- Farmers produce, assemble, grade transport and sell commodities.
- Itinerant traders are assemblers of goods which they collect from different parts of the rural areas where farmers are found.
- They spend on sacks and transport before selling at a profit or commission.
- The total marketing costs would be calculated as follows:
- Itinerant trader charges +Wholesaler charges +Retailer Charges
  = K900.00+K600.00+K 1200.00

  = K 2700.00.

- Marketing margin =Market Costs
- Market margin =Retail price –Farm gate price

Ways of reducing marketing costs.

1. **Raising price of farm produce**
   - This makes the farmers to get fair prices however final consumers buy commodities at a very high price.

2. **Performing some of the marketing functions**
   - Farmers can do some of the roles of the market agencies and ensure that they are paid fairly for their efforts .e.g. grading their produce before selling.

3. **Eliminating some of the marketing functions**
   - The farmer can avoid some of the marketing functions such as grading if the produce is 100% purity.

4. **Skipping some marketing agencies**
   - The farmer can sell directly to the wholesaler or retailer and reap all the profit.

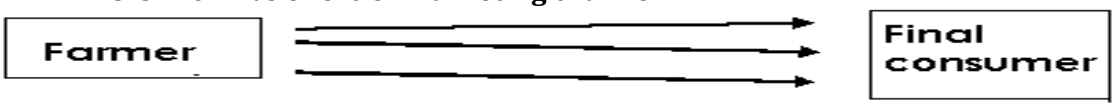
5. **Selling through cooperatives**
   - Since a marketing cooperative has more bargaining power than a single farmer, a farmer can therefore sell the produce at a higher price.

6. **Reducing consumer prices at the retail level.**
   - Although farmers have powers to lower prices at consumer level, Consumer Association has the mandate to regularize the retail prices so that the consumers pay fairly.
   - Market Channels and Agencies
   - Market channels are routes through which farm produce move from the point of production to the point of consumption (consumer)

Types of marketing Channels

1. Direct marketing Channels

- Farmers deliver and market their own produce to final consumers
- This is known as **one–tier marketing channel.**



- This means that a farmer sells own produce to many buyers directly.

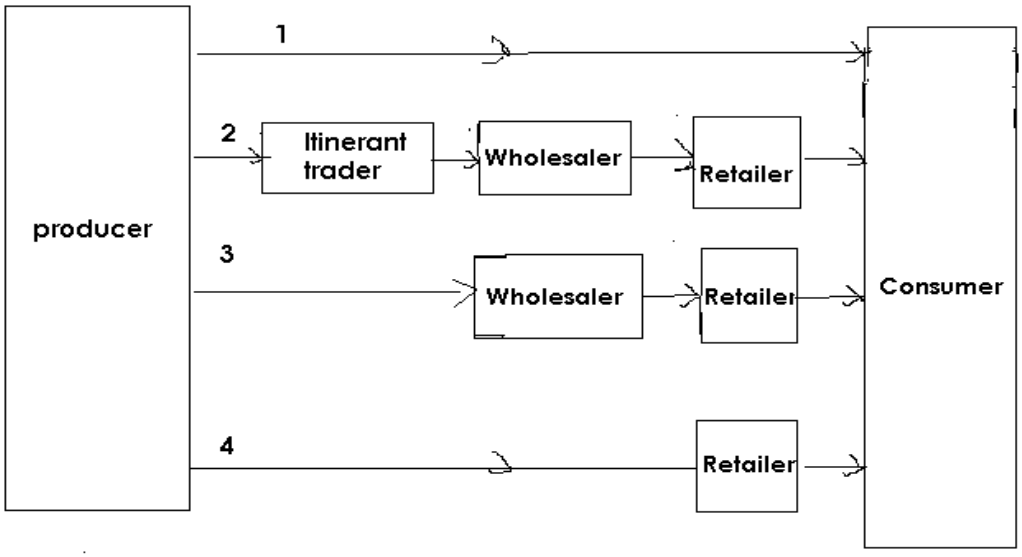
2. Indirect Marketing Channel

- Many farmers use middlemen to get their produce to the final consumers
- This is a **Two-tier marketing Channel**

- In a two–tier marketing channel the farmer needs to sell the produce to just one man who in turn sells it to all the final consumers.

3. A Three –tier marketing channel.

- In this channel a farmer sells the produce to the wholesaler who in turn also sells them to retailers.
- The final consumers buy the produce from the retailers.
- For example Dudu chicken farmer sells the chickens in bulky to Metro Shops who later sell them to restaurant owners as retailers. The final consumers buy the chickens through paying for the food prepared in the restaurants.



Examples of Market Channels

- The main role of the market channel is to facilitate the transfer and flow of farm produce from farmers to consumers.

Marketing agencies and their functions

Marketing Agency	Functions
Producers	• Selling own commodities. • Grading. • Storing. • Processing. • Transporting.
Itinerant traders	• Assembling. • Transporting. • Linking farmer and wholesaler or retailers. • Buying commodities at their own risk of price fluctuation. • Storing the produce. • Supplying information.
Wholesalers	• Provide trained sales forces. • Market research. • Storage. • Transportation. • Financing e.g. giving loans or credits. • Risk bearing – responsible for theft.
Processing companies	• Buy from producers. • Process the raw materials. • Transport and sell finished products to. Wholesalers or retailers.
Produce marketing cooperatives	• Assemble farm produce from farmers. • Sell farm produce to processing companies. • Buying farm produce in bulky at discount prices.
Marketing companies e.g. ADMARC	• Pricing. • Buying and small holder food and cash crops. • Selling food crops e.g. maize, rice. • Transporting farm produce. • Risk bearing against loss through insurance.
Retailer	• Gathering different commodities. • Paying supplies of different commodities. • Storing commodities. • Providing information to consumers. • Conducting market research. • Transporting commodities.

TOPIC3: EFFECTS OF POPULATION DISTRIBUTION ON MARKETING

Population in a country is distributed according to:

1. Location

- Some areas are heavily populated than others.
- Urban areas have more people as compared to rural areas.

2. Education

- Some areas are dominated by people with high education levels such as the urban. On the other hand rural areas are dominated by people with low education status.

3. Income.

- Some areas especially cities people have higher income levels as compared to their counterparts in the rural areas.

4. Age.

- Population is also distributed according to age.
- The rural areas have more old people and young ones while the urban areas have a large population that are middle aged because these are job seekers who migrate to urban areas for employment.

5. Gender.

- This is variational. In some areas there are more females than males. According to 1998 population census 51% of the total population in Malawi was females.

Effects of population distribution on marketing

- Marketing success or failure depends on the combination of the four Ps.
    1. Place
    2. Product
    3. Promotion
    4. Price.

1. Place.

- Population of a place affects marketing in the following ways:

i. It affects the direction of the flow of commodities.

- More goods flow to areas with high population since there is great demand for goods.
- For example there is large flow of commodities to the cities than to the rural areas

ii. It affects the length of the market channel.

- Areas with large population have longer market channels as compared to to areas with low population.

iii. **It affects the method of transporting the products to the consumers.**
   - Goods going to areas with large population like cities are transported by lorries while in areas with low population like villages goods are carried by even on bicycles.

2. Product.

- This is to do with the quality and quantity of the commodity.

i. **Population distribution affects the quality of the products.**
   - For example in the urban areas there are more people who are of high income level as well as high education level. These have a preference of high quality products because they can also manage to pay for them.
   - In areas of high population distribution large amount of products **(quantity)** are required to meet such high demand of goods. In such areas **storage** and **grading** functions also have to take place.
   - It affects the range and form of products in the market.

ii. **Different people have different tastes and preferences.**
   - For example the cities which comprise a large population of different levels of people, a wide variety of goods are needed hence processing need to be done to meet people's preferences.

3. Price.

- The price of a commodity depends on demand and supply.

i. **Population distribution affects demand for marketing services.**
   - Areas of large population usually have a greater demand for marketing services.
   - The high demand increases the price on the commodity that farmers and middle men get for their marketing activities.

ii. **Population distribution affects the supply of marketing services.**
   - Higher populated areas stimulate producers and middlemen to provide more commodities.
   - However this may lead to lowering of the prices because the supply of goods to a certain extent reaches a saturation point.

5. Promotion

- This affects the type of people to target.
- You concentrate your advertisement where you can get maximum sales or profit.

1. **Population distribution affects types of advertising method s used**
   - In most populated areas it is easier to advertise using mass media (radio, print media), trade fairs or agricultural shows while in less populated areas personal selling is more common.

TOPIC: 4 TRADING AGRICULTURAL COMMODITIES

- Trading means buying and selling at a profit while marketing is a process that involves identification of consumer needs and meeting the satisfaction of those needs through activities such as grading, processing, transporting, storage, risk bearing, buying and selling at a profit.

Functional differences between marketing and trading

Marketing	Trading
• Covers a broad range of activities (market functions).	• Only deals with buying and selling.
• Puts emphasis on consumer analysis and satisfaction.	• Emphasis is on sales.
• Takes a long process of research before exchange function.	• Begins and ends with exchange functions of buying and selling
• Uses selling as a means of communicating and understanding with consumers.	• Uses selling as a means to an end.
• Directs the resources from the farm to produce the commodities that consumers want.	• Directs resources to bring about a sale/purchase.
• Makes attempts to adapt to changes in consumer characteristics or needs e.g. changes in taste leads to changes in the commodity.	• Makes efforts to develop stronger sales drive, for, example, change in consumer taste will cause change in sales strongly.
• Seeks to anticipate, manage and satisfy demand at a profit	• Seeks to dispose of a surplus at a profit.

Importance of trade and marketing at community level

- Trading encourages community members to engage in enterprises that are profitable.
- When goods produced are sold to each other, everybody benefits.
- Income from sales raises people's living standards.
- Trading promote specialisation.
- Trading increases people's productivity.
- Trading promote efficient division of labour.
- Trading provides an outlet for surplus from farm holding.

Importance of trading at national level

- Creates job opportunities.
- Promotes efficient allocation of resources.
- It increases national output since workers are more productive.
- Promotes the development of local agro-based industries through the provision of raw materials.
- Trading enables the urban population to get food.
- Trading empowers the people economically.

Importance of trading at international level

- Enables a nation to earn foreign currency.
- Enables each country import what it cannot produce.
- Enables consumers to have a wider choice of products.
- Enables a country to obtain funds through taxation from import duties.
- It increases business profit for wholesale traders.
- Widens market for agricultural products.
- It creates great pressure on farmers to be more efficient in order to compete internationally.

How to improve trading of agricultural commodities at community level

- Promote good neighbourliness.
- Increase efficiency of production to ensure surplus.
- Promote development of rural growth centres which act as trading centres e.g. Mkhota, Mbalachanda, Thekerani, and Nambuma.
- Improve transport networks.

How to improve trading of agricultural commodities at national level

- Improving transport network.
- Promoting peace.
- Providing adequate market information.
- Removing surtax on agricultural commodities.
- Encouraging development of cooperative.

How to improve trading of agricultural commodities at international level

- Promoting good international relations.
- Increasing the amount of goods for export.
- Improving transport and storage facilities at entry points.
- Competitive pricing.
- Improving advertisements and sales promotion (trade fairs).
- Establishing a stable and competitive exchange rate.
- Improving the quality of agricultural produce to attract external buyers.
- Reducing or removing trade barriers e.g. tariffs, import quotas, exchange controls and embargoes.
- Providing adequate information on potential exporters about international markets, customers and producers.

UNIT5: FARM BUSINESS MANAGEMENT

TOPIC 1: FARM RECORDS

Reasons for keeping farm records

- Helps the farmer to know the time for various farm activities
- Helps farmers in planning
- Helps farmers in budgeting
- Helps farmers to know whether they are making profit or losses.
- Help farmers to obtain credit or loans from farm lenders
- Help farmers in selecting the type of animals to keep because they have a record of production for each animal.
- Help farmers to check on their methods of production
- They provide history of farming activities and enable them to compare with other farmers
- They help farmers to calculate the amount of tax to pay.

Types of Farm Records

1. **Inventory records**
   - This is the list of all properties and assets that are available on a farm
   - This record is best done at the end of the farming season
   - Inventory records can be taken through
     - Counting the items physically
     - Estimating the value of assets
     - Physical measurement of land, buildings etc.

2. **Financial records and accounts**
   - One of the major reasons for keeping records is to know whether the farmer is making profit or loss. In view of this a farmer needs to keep accurate records about expenses sales,
   - Farmers need to keep proper accounts e.g. cash book for cash account and bank account, stores ledger, etc.

Cash Book for a Farmer

Date	Income/Receipts	Cash	Bank	Date	Expenditure	Cash	Bank
1/6/10	Balance in hand	K20000					
2/6/10	Banked		K12000	**2/6/10**	Banked	K12000	
3/6/10	Sold fish	K6000		**5/6/10**	Paid wages	K 1000	
11/6/10	Withdrawal	K3000		**11/6/10**	Withdrawal		K 3000
				17/6/10	Paid wages	K 1 200	

		K29000	K 12000	**30/6/10**	Balance C/F	K14 800	K 6000
1/7/10	Balance C/F	K14800	K 6000			K29000	K12000

3. Production Records

- This records progress of production for crops and animals.
- Inputs and output of production are normally recorded
- Therefore under this category there are crop production record and livestock production record
- Labour record should also be kept under production records.

Production records

Type of livestock	**Records to be kept**
Cattle: Dairy	Breed record Feed consumed Milk yield each cow/each day,month,year Medicines Labour Sales
Cattle :beef	Breed kept Labour Live weight gain Vaccination Medicines Feed consumed Sales
Poultry: layers	Number of birds Mortality Total feed consumed Feed cost Housing equipment Number of eggs/day and egg sales

Poultry : broilers	Number of chicks bought Mortality Total feed consumed Cost of feed Drug and cost Labour

Trading Account Template

Opening Valuation	Sh	Sales and Receipts	sh
Live stock: Cattle	48 400	**Milk**	**36 840**
Sheep	3600	Sheep	2 160
Crops: Maize	7200	Maize	37 600
Potatoes	4800	Potatoes	31 760
Stores: Seeds	1240	Miscellaneous	5 640
Feeds	2500		
Total	67740	Total	114 000
Purchases and expenses		Closing valuation	
Livestock feeds	**12 600**	**Live stock: Cattle**	**46 800**
Fertilizer	3960	Sheep	4300
Seeds	4350	Crops: Maize	4560
Tools and supplies	5850	Potatoes	6400
Machinery operation	11400	Beans	1650
Machinery repairs and maintenance	7550	Stores: Seeds	850
		Feeds	2500
		Fertilizers	3960
Depreciation			77640
Machinery	**3600**		
Buildings	8940		
Labour	16760		

Bank charges	1980		
	76 990		
Profit	46 910		
	191 640		191 640

Balance Sheet

Liabilities			**Assets**	
Bank loan	30 000.00		Cash in hand	5000.50
Bank over draft	5000.00		Cash at bank	9950.00
Interest payable	600.00		Debts received	3649.50
Debt payable	4000.00		Tractor value	20 000.00
			4 Heifers	14 000.00
	39 600.00		Remains of seeds and fertilizers	400.00
			Value of buildings	30 000.00
Net capital	83 400.00		Land value	30,000.00
			Value of crops	4 000.00
	123 000.00			**123 000.00**

Trading Account Year ending

Opening Valuation		sales and receipts	
Expenditure		Closing Valuation	
Profit		Loss	

TOPIC 2: DECISION MAKING AND ENTERPRISE COMBINATION

- Enterprise combination is aimed at profit making and needs sound decision making.
- Decision making is crucial when choosing the enterprise and this is affected by a number of factors which include the following.

1. **Availability of farming resources**
   - Land
   - Labour
   - Capital
   - Managerial skills
   - The farmer's food requirements

2. **Profitability of Enterprises**
   - Farmers need to choose those crops that will give them the highest returns and gross margins.

3. **The Nature of enterprises**
   - The farmer needs to have clear knowledge that some enterprises are competitive while others are complementary or supplementary

   i. ***Complementary or supplementary***
      - These are enterprises that increase in them by a farmer does not affect the other because they do not compete for resources but rather they make another enterprise benefit from them e.g. maize and ground nuts, keeping of ducks and fish.

   ii. ***Competitive Enterprises.***
      - The increase in one enterprise will cause a decrease in another because they compete over resources e.g. land, capital and labour.
      - Whether competitive or supplementary enterprise the most important consideration is the net return or revenue from the enterprises**.**

4. **Opportunity cost**
   - This is the return that is given up. For example if due to price reduction in tobacco the following year a farmer decides to increase the size of maize field and reduce the same
   - Farmers need to make wise decisions because opportunity costs come every year.

5. **Comparative costs.**
   - Farmers should consider choosing those enterprises that best suit in the area by producing high production for example farmers in Thyolo and Mulanje have a comparative advantage in the production of bananas and pineapples over farmers in Lilongwe and Kasungu. Farmers in Dedza and Ntcheu have CA in the production of tomatoes, onions, beans and cabbages over people of hot areas of Zomba.

6. **Risks and Uncertainty**
   - Risks are predictable while uncertainties are not predictable.
   - Even when you know what will be an outcome you take a risk by growing some crops.
   - In uncertainty you may not predict that there will be fire, hailstorms drought or locusts.

- To solve this challenge that farmers face, they need to
  - Select a more reliable enterprise that will un likely fail
  - Produce several crops **(crop diversification) e.g.** grow cassava, millet and potatoes instead of relying on maize only.
  - Be flexible in modifying methods of production e.g. from dairy to beef.
  - Practice input substitution e.g. instead of using expensive fertilizer, a farmer can start using manure.
  - Storing food in reserves for food security during bad season
  - Insuring the enterprises
  - Rationing the inputs where by a farmer uses little of the required amounts so that the remaining amount will be used later if yield fails.

7. The farmers Abilities

- Farmers need to be knowledgeable of the skills (e.g. planning and budgeting) involved in the production or processing of the enterprise in order to make profit.
- This can be done by making sound decision

8. Changes in prices and technology

- Farmers need to be flexible and lean towards those enterprises that can be economical to produce in terms of food and give them high selling prices for profits.
- Farmers also need to be sensitive with the change in technology. For example drought conditions may influence farmers to adopt new seed technologies as e.g. hybrid seeds
- Irrigation technology may be adopted to suit not only drought conditions but also meet the demands of high population growth.

Other addition factors in enterprise combination include

- The crop rotation to be used
- Input requirements
- Expected price to be offered on market depending on demand and supply

TOPIC3. FARM BUDGETING

Types of farm budgets

1. **Partial budget**
   - This is the type of budget that affects only part of the farm because it does not include everything being done on the farmers (variable and fixed).
   - A Partial budget is used to evaluate small change to a part of the farming system.
   - It tries to examine the effect the change will have on the profitability of the farming enterprise.
   - Only those costs that will be incurred as a result of the change are considered in a partial budget.

What to be born in mind when preparing a partial budget

- What extra costs to be incurred
- What existing income is to be forgone or given up
- What extra income is to be earned
- What existing costs are to be saved
  - If the total costs are more than income, then the proposed change will not be profitable.
  - If the income outweighs (more than) than the costs, then the change is likely to be profitable.
  - The partial budget therefore shows the anticipated net gain after expenses have been paid.

Uses of partial budget

- It is used to expand the existing enterprise i.e. increasing the area for crops or number of livestock
- Change one enterprise for another (substitution)
- Introduce a new enterprise without changing existing ones.
- Buy new farm machinery or equipment.
- Adopt change in a method of production i.e. introduce machine for shelling maize instead of using hands.

Preparing a partial budget

- Mr. Phiri wants to store his maize in sacks and sell it later when then there is high demand. The maize yield that he got from 0.5 hectare is 100bags of 70kgs each. The main extra costs made are:
  - The cost of sacks
  - Casual labour; (to process the maize)
  - Actellic dust

A Partial Budget

Total Cost of Change	**Total Income from Change**
1. Extra costs	**3. Extra Returns**
100 sacks at K50.00 each =K 5000.00	Sales of stored maize: 100 bags at K1200.00

13 bottles of actellic at K150.00 each =K1950.00	Sub Total =K120, 000.00
Cash labour K1000.00 **Sub Total: K7950.00**	**4. Saved Costs** Nil
2. Present Income sacrificed	**5. Total Income**
100 bags of maize at K500.00 **Total cost = K50,000.00**	K120,000 - (K7950+K50,000) = K62050 K120,000 –K57950 =K62 050

- On account of the prepared partial budget above, it is advisable for Mr. Phiri to continue with his plan because at the end the income is more than the incurred costs.

2. Complete Budget

- This is the type of budget that examines the effect of changes made to the whole farm.
- Usually a complete budget is prepared when a farmer is
  - Opening a new farm
  - Intends to carry out a major reorganization of the farming system
- It includes all estimated costs to be incurred in a particular year.
- Complete budget is made by subtracting fixed costs from the total gross margins for the various enterprises.
- This shows the net profit for the plan.

How to prepare a complete budget

- Make an estimate of what it is possible to produce bearing in mind limiting factors to production.
- Estimate the expected yield of crops, or output from animals.
- Estimate the input requirements.
- Estimate the expected prices of crops and animal output and cost of variable costs (inputs).
- Estimate the costs of permanent labour, machinery and equipment (fixed costs).
- Estimate other costs such as depreciation of buildings and equipment.
- Calculate the total costs, total returns and profit from the plan.

A Complete Budget

Category	**Maize**	**Rice**	**G/nuts**	**Cotton**	**Tobacco**
Yield(kg/ha)	4000	2000	500	1000	700
Price (K/Kg)	20	150	100	70	149
Gross Income (MK)	80000	300000	50000	70 000	104 300
Variable Costs (MK)					
Seeds	7500	2000	5000	500	350

Fertilizers	40 000	20 000	-	-	56000
Pesticides	3000	1000	-	8000	
Casual labour	10 000	5000	15 000	20 000	15 000
Total Variable Costs (MK)	60500	28000	20 000	28000	71350
Gross Margin /ha	19 500	272 000	30 000	42 000	32950

- In the complete budget prepared above, it is advisable for a farmer to go ahead with his/her plan because the total cost of variables is less than the anticipated gross income.
- When the gross margin is very big it shows that the farmer will make more profits but if the gross margin is very small, the farmer may not be encouraged to go ahead with the plan.

TOPIC 4. AGRICULTURAL COOPERATIVES

- A cooperative is an organization or group of people who join together to pull their resources and services to achieve a common goal.
- A cooperative is registered to make it legally binding.

Importance of cooperatives to farmers

- Produce or market commodities cheaply because of the resources available and shared expertise.
- Secure loans from commercial banks for farmers.
- Buy inputs for farmers cheaply because they purchase them in bulky.
- Make use of expensive machinery which an individual farmer would find. It is expensive to buy or hire.
- Help famers to benefit from economies of scale (able to keep over head costs low because they are shared)
- Transport farmers produce to the market.
- Bargain on behalf of farmers for better prices or selling conditions as a group.
- Sell commodities and farmers share accordingly.
- Storage and processing farmers produce.
- Assists farmers to quickly adopt innovations because they share expertise and knowledge.

Principles for the formation of cooperatives

- A cooperative should be legally constituted with guiding rules or regulations
- Participation is voluntary
- Cooperatives are impartial and not based on political or religious grounds
- A cooperative is open to all farming community members
- It is run according to democratic principles
- It must have a committee of 10 members who are democratically elected

Factors that make cooperatives successful

- The leadership of the cooperatives should have expertise and be trustworthy and highly innovated.
- Enough capital or funds .
- Efficient and effective organization.
- All members should be committed to work for the success of the cooperatives.
- Availability of adequate infrastructures e.g. staff houses, offices, storage facilities, personnel, transport, equipment and supplies.
- Members should receive ongoing and relevant training to improve productivity and marketing skills.

UNIT 6: AGRICULTURAL TECHNOLOGY

TOPIC1: FARM ENERGY

- Farm energy is the ability to do work on the farm.

Forms of Farm Energy

- Solar energy
- Sound energy
- Electrical energy
- Fuel energy
- Mechanical energy
- Wind energy
- Water energy
- Chemical energy
- Light energy

Sources of Farm energy

- Solar energy
- Water energy
- Fuel energy
- Biogas
- Animal draught
- Human power
- Electricity
- Mechanical power.

Safety Measures When Using Farm Energy

- Petroleum products should be handled with extreme care since they are highly inflammable and should not be stored anywhere.
- Running engines should be switched off when refueling at pumping stations.
- Do not expose fuels to a naked flame or fire because this causes explosion.
- Do not wear loose clothes when working with machines.
- Electric wires should be treated as live at all times to avoid being electrocuted.
- Wear sun glasses when working in the sun.
- Water reservoirs should be protected to prevent people from falling in them.
- Keep paraffin away from children.
- Gases should be carefully handled because they are also highly inflammable.

TOPIC 2: IRRIGATION SYSTEMS AND DRAINAGE

A. IRRIGATION

Selecting an Irrigation System

- When selecting an irrigation system the following should be considered
  - Characteristics of each system.
  - Amount of water available.
  - Capabilities of the people.
  - Topography of the land.
  - Knowledge of the people.
  - Labour and capital available.
  - Type of soil and its characteristics.
  - Type and value of the crop to be grown.
  - Demand for the crop.

Types of irrigation systems and their characteristics

System of irrigation	Characteristics
Furrow irrigation	• Water is led by gravity along furrows. • There are channels between plots and rows of crops. • The system needs more water. • It requires land which is sloping. • It does not use water economically. • The ground between the furrows is wet by water from the furrows
Flood irrigation	• Requires a lot of water. • Whole area is submerged in water. • Requires heavy clay soils for water to be retained for a long time. • Suitable for crops which can grow in standing water. • Needs a levelled or flat ground.
Basin irrigation	• Water is directed to the basins. • Suitable for orchards and paddy rice.
Drip irrigation	• The water is conveyed through plastic pipes which may be laid on the surface or under the ground. • The pipes have small holes. • Uses water economically. • Suitable for areas where water is scarce. • It is risky when there are strong winds. • The pipes may be blocked. • Piping may be expensive. • Can be used on slopping land. • Does not require much labour once established.
Overhead	• Does not require much labour once established. • Can be used on most soils and land with varying slopes. • Requires expensive equipment (sprinklers).

or sprinkler	• Do not require much labour. • The water applied can be controlled. • It is the most effective method of irrigation. • There may be uneven distribution of water. • Difficult when there is strong wind.

Factors to consider when setting up an irrigation system

- Capital availability – you need to know the amount of capital required.
- Source and quality of water – permanent water source which is accessible.
- Type of land – natural slight sloppy areas.
- Maintenance – consider how the system is to be maintained.
- Type of soil and crop to be grown – the type of soil should be suitable for irrigation as well as the crops to be grown.

Managing an irrigation unit

1. **Frequency and timing of watering**
   - When deciding how much water to apply and when to apply.

2. **Amount of rainfall**
   - Irrigation is needed when rainfall is insufficient or persistent drought.

3. **Amount of water applied during the last irrigation**
   - This is considered to avoid losing water in excess.

4. **Crop requirement**
   - The age and condition of the crop determine the amount of water and frequency of irrigation.
   - Young plants may require less water than old plants.

5. **Weather conditions**
   - This affects loss of water from the surface and plants through evapotranspiration.
   - Do not irrigate more water in humid conditions but in sunny conditions crops need more water to avoid wilting.
   - Make allowance of some water for losses due to evaporation and transpiration.

6. **Type of soil**
   - Clay soil may not require frequent watering.
   - Sandy soils will require more water.
   - It is necessary to ensure balance between the infiltration rate and loss of water from the surface or plants.

7. **The condition of the soil**
   - Make sure that water remains in the soil between wilting point and field capacity (available soil water).

- Field capacity is the maximum amount of water that soil holds against the force of drainage.
- Irrigating the soil when it is at field capacity results into water logging.

Problems associated with irrigation

1. **Salt accumulation**
   - Irrigation water contains dissolved salts which tend to accumulate in the soil as a result of evaporation.
   - Soil structure get destroyed by sodium salts through deflocculation (dispersion of soil particles)
2. **Soil erosion**
   - This is caused by
     - Excessive application of water.
     - Breakage of basins or furrows.
3. **Siltation and blockage of irrigation pipes**
4. **Water logging**
   - This results from applying too much water.

Solutions to problems associated with irrigation

- Salt accumulation can be controlled by flooding with salt-free water.
- Application of gypsum corrects alkalinity.
- Soil erosion can be reduced by proper maintenance of irrigation structures.
- Removing the silts from time to time.
- Control water logging by reducing frequency of irrigation.

B. LAND DRAINAGE

- Land drainage is the removal of excess water from the soil.
- Land drainage becomes necessary when the water table is high.

Importance of land drainage

- It reduces the input of water into the soil.
- It increases the rate at which water is removed after infiltrating the soil.

Methods of land drainage

1. **Artificial ways of land drainage**
   i. Use of open ditches
   - It is easy and cheap.
   - These help to carry excess water off from the land, however, they have the following disadvantages:
     - They occupy land that would otherwise be used for crop production.
     - They obstruct machinery where mechanization is practiced.
     - They harbour rodents which destroy crops.

   ii. Sub-surface drainage
   - These remove excess underground water to canals or rivers.

- They lower amount of underground water to reduce water logging.
- However, these are more expensive.

2. Natural ways of land drainage

i. Transpiration through plants.
ii. Surface run-off.
iii. Percolation.

Effects of water logging

- Poor aeration.
- Retarded microbial activity.
- Soil becomes cold.

Benefits of drainage

- It improves soil aeration.
- It enhances soil microbial activities.
- It warms up the soil which enhances seed germination and root development

TOPIC 3: FARM MECHANISATION

- Farm mechanisation is the process of using machinery for the production, processing and storage of agriculture produce in order to improve quality and quantity of products.

Advantages of Mechanising a Farm

- It ensures that farming operations are done faster and finished in right time.
- Farm mechanisation leads to increased production of crops and livestock fields.
- It makes work easier.
- Farmers can do the job which could be difficult without machinery e.g. clearing large forests or cultivating a very dry ground.
- It releases farmers' time for other activities.

Limitations of Farm Mechanisation

- Mechanisation makes other people jobless because the job that was done by people is done by machinery.
- Quality of work may be poor because of the speed of operation.
- Farm mechanisation is very expensive because it needs a lot of capital and operating costs.
- In Malawi most of the machinery are imported e.g. tractors and this leads to a great loss of foreign exchange.
- It causes soil compaction due to the use of heavy machinery leading to poor drainage.
- Requires skills to operate and maintain.
- The choice of crops to be grown is limited because some crops cannot be mechanised e.g. sweet potatoes.
- Requires large farm holding.
- Some materials such as fuel to run the machines may not always be available on the farm and this slows farming progress.

Factors to Consider when Mechanising a Farm

- Size of the farm holding should be large but small holder farmers can combine their farms and hire tractor from the government.
- The land should be accessible to machines such as tractors.
- Mechanisation should be done on a flat topography.
- Sufficient capital for buying machinery and spare parts.
- Technical know-how – mechanisation needs skilled personnel to operate, maintain and repair machinery.
- Value of the crops grown under mechanisation should be high to recover the costs of machinery.
- The market demand for crops should be high.
- The farmer's attitude should be positive towards mechanisation.

FARM IMPLEMENTS

Types of Farm Implements

Ox-drawn implements	Tractor-drawn implements
Ox-cart	Disc Plough
Mould board plough	Disc harrow
Ridger	A Spring-toothed harrow
An adjustable cultivator	Spike toothed harrow

Oxen drawn implement

Ox cart kept under dry Shade.

A Brahman –A draught animal being feed with Extra Ground nuts haulms in a dry shade.

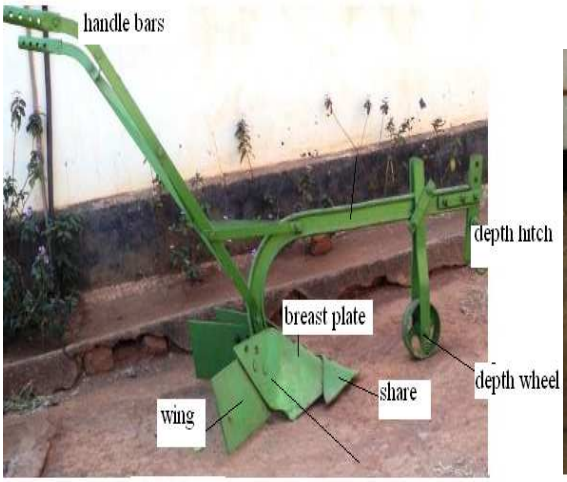
General Maintenance Methods of Farm Implements

- Use each implement correctly by putting it to its proper use.
- Clean the tools and implements after use.
- Service the machines regularly.
- Lubricate all moving parts to reduce wear and tear.
- Tighten all loose bolts and nuts.
- Replace worn-out parts.
- Grease the share and mould board.
- Repair broken parts.
- Sharpen blunt parts.
- Sprayers, ox-carts and ploughs should be stored in a dry place.
- Make sure that the tractor has enough oil.
- Check that tyres are always kept under enough pressure.
- Paint the implements once at a time to prevent rust.
- Dismantle and clean nozzles of sprayers.

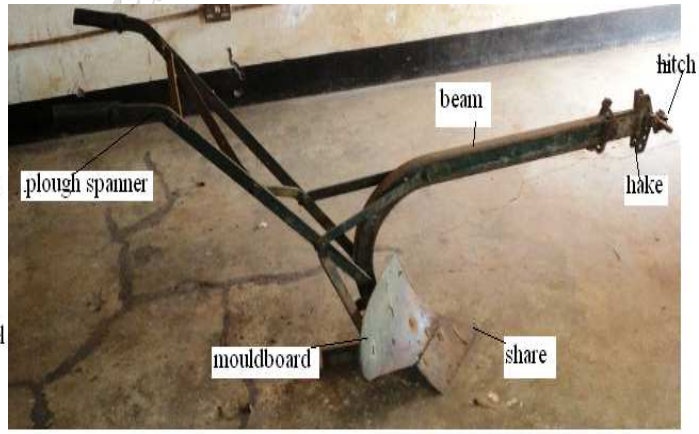
Safety Measures to be observed when using Farm Machinery

- Do not overload ox-cart, wheel-barrow to prevent them from overturning.
- Wear protective cover when spraying chemicals.
- Wash your body thoroughly with soap after spraying.
- Do not smoke or it when spraying crops.
- Avoid spraying against the wind.
- Dispose empty containers of chemicals properly.
- Keep children away from working machines and chemicals.
- Carry sharp bladed implements with the sharp blade facing downwards to prevent accidents.
- Keep fuels and oils in safe place.
- Switch off engine when fuelling or servicing.
- Do not wear loose clothing when working with rotating machines.
- Do not remove the radiator cap when the radiator is hot or boiling or avoid pouring cold water in a hot radiator.
- Make sure always that steering and brakes are in good working condition to avoid accidents.

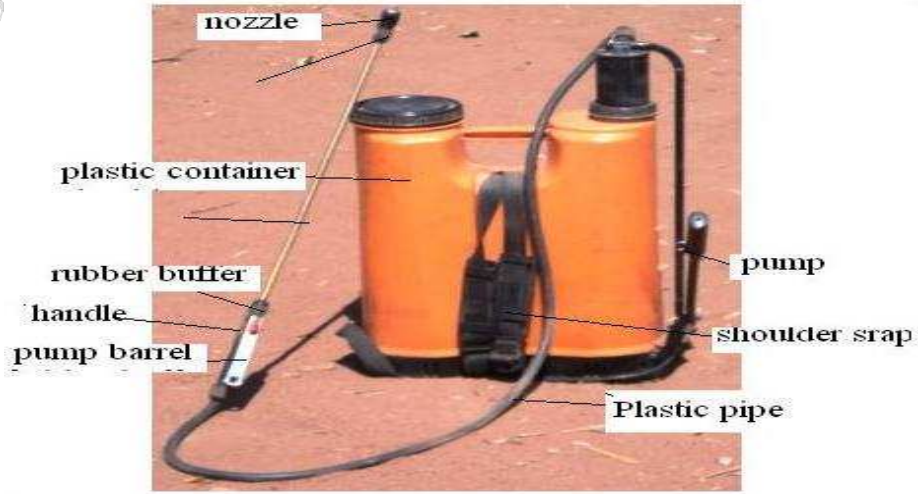
Some examples of farm implements



A mould board plough



A Ridger



A sprayer

A disc harrow plough

A tractor

UNIT7: AGRICULTURAL EXPERIMENTATION

TOPIC 1: BASIC PRINCIPLES OF AGRICULTURAL EXPERIMENTATION

- Agriculture experimentation is the scientific approach to testing a hypothesis in order to find out the truth through observation of cause and effect to draw conclusions through induction.
- The purpose for carrying out agricultural experiments is to improve crop production
- A hypothesis is a statement which is not proved and it needs to be tested first and when the cause and effect are studied, the statement becomes a fact.i.e.
- Early planting increases crop yield
- Maize variety has an effect in crop production.

Principles or steps in scientific approach

- Identifying a problem or area of study .i.e. Weeding methods in maize.
- Clarifying aims, objectives or hypothesis in order to be sure of what you want to
- achieve by attempting to solve a problem. I.e. to find out which spacing of MH 12
- maize gives highest yield.
- Setting up the experiment to the hypothesis .This involves designing and laying out the experiment in the field.
- Collecting information (data) by taking observations or measurements.
- Analyzing measurements, observations or results. i.e.
- calculating average measurements taken. For example the average yield of
- MH 12 maize from each spacing.
- Evaluating the results .i.e. judging by comparing the average yields from different
- spacing.
- Drawing conclusions.
- This is deciding on the best spacing of MH 12 Maize..

Note: The recommendations made depend on the type of conclusions.

Problems requiring experimentations.

- There are several problems for agriculture experimentations. I.e. To find out the
- effect of different mulching techniques on the yield quantity of maize.
- effect of different Soil textural classes on the yield quantity of maize
- effect of different Varieties on the yield quantity of maize
- effect of different Fertilizer on the yield quantity of maize
- effect of different Planting times on the yield quantity of maize

Experimental Designs

- In experimental designs the area is divided into plots and the different varieties or management practices are assigned on to each plot.
- The yield and plant other characteristics are measured from each plot.
- Even if the same variety is shown on all plots substantial differences in yield occur from plot to plot.
- There may be variations across a field in terms of soil fertility ,texture slope etc.

Choice of Treatment

- The first step in planning an experiment is to decide what is to be studied and nature of the

variables to be compared.

- In an experiment to study the effects of different rates of muriate of potash fertilizer on tomato production, the effect whose effect is to be compared

Treatment	Rate (kg/hectare)
1	0
2	50
3	100
4	150
5	200
6	250

- In such experimental designs one treatment must be a control which is a standard treatment against which the rest of the treatments can be compared checked or judged.
- A control is usually most familiar to researchers. For example 0 kg per ha rate is the control treatment of the experimental designs above.

How to design experiments that give credible results

- To avoid bias or prejudices by experimenters where by some treatments may be favoured , treatments should be allocated to different plots by chance. The chance allocation can be done through randomization.

Methods of randomization

1. Tossing a coin.

- Generally used when there are only two treatments to be compared.
- The coin is tossed and treatments are done according to what turns on top either head to mean treatment 1 or tail to mean treatment 2.

2. Throwing a dice.

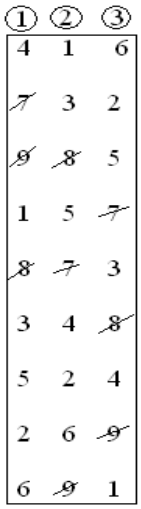
- This is used to allocate up to six treatments. The first throw will determine which treatment will be allocated on plot 1.For example if the dice faces upwards showing a side with 4 dots, and then the first treatment will be number 4.

3. Using numbered pieces of paper.

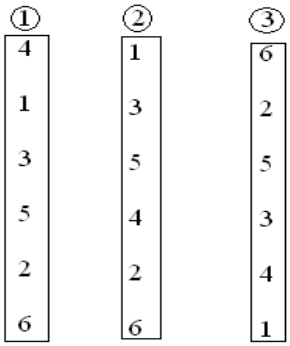
- Each treatment is written on a piece of paper and placed in a container folded and shaken. One piece is taken at a time. The first paper selected is allocated plot 1, second to plot 2 and so on.

4. Using random number tables.

- When you have six treatments arrange the numbers 1-9 in a mixed order.
- Omit all numbers that are not within the range of 1-6 as follows:



In this figure, the treatments can be randomised as shown



- This means that each treatment has been repeated in three fields or blocks.

Replication

- For reliable results, the experiments should not only be done once. There are environmental influences that interfere with the results of the treatments. Replication therefore is the repeating of each treatment in different fields or blocks so that the results will be reliable.
- Using the number tables above replication can be organized as shown below.

Plot	Block 1	Block2	Block 3
1	T4	T1	T6
2	T1	T3	T2
3	T3	T5	T5
4	T5	T4	T3
5	T2	T2	T4
6	T6	T6	T1

- If one treatment out performs the others in all replicates (blocks) it will have the highest average yield and its superiority cannot be doubted.
- This should be recommended as the best for implementation in order to improve crop production.

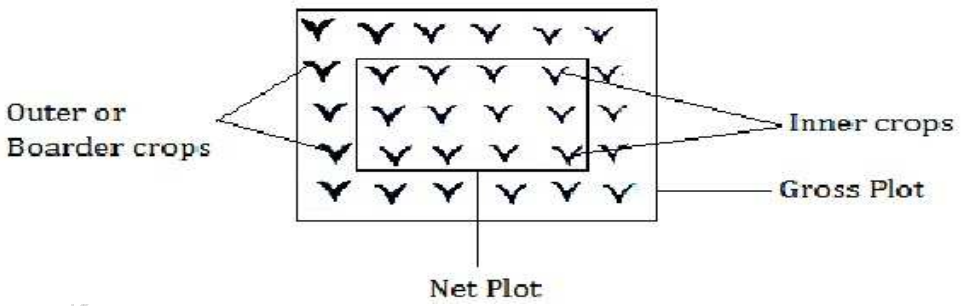
Carrying out experiments

- All experiments have to be managed equally except the one being tested.

Experiment	What can be changed
Spacing trial	Spacing between planting stations or rows
Depth of planting trial	Depth of planting holes
Amount of fertilizer trial	Rates of fertilizer applied/ha or station
Watering trial	Amount of irrigation water used.
Pesticide application trial.	Type of concentration of chemicals used to control pests.

DATA COLLECTION

- Experiments are done in an experimental plot. However not all the crops in this plot can be observed or measured for collecting data. Only sampled crops are used and these are usually sampled from among inner crops because the results are not influenced by boarder effects. Some of the boarder influences that can affect results if crops for data collection are chosen from the boarder crops include;
  - Pollination from neighbouring fields
  - Pests and diseases
  - Alluvial deposits
  - Erosion of plant nutrients.
- Even among the inner crops sample crops are chosen randomly.



An Experimental plot

Data Analysis

- Data can be analysed using graphics such as tables, charts, graphs and histograms among others.

Treatment	Rate of fert(kg)/ha	Yield kg/ha
1	0	0.5
2	50	300
3	100	460
4	150	570
5	200	640
6	250	580

Figure: a. showing the yield against each treatment in every plot

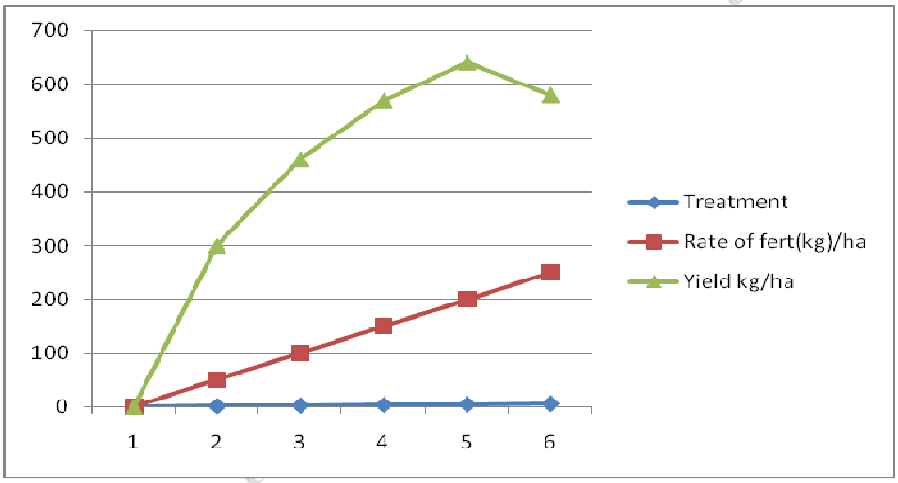


Figure: b. showing the yield against each treatment in every plot

TOPIC 2.REPORTING FOR AGRICULTURAL EXPERIMENTS

- Agricultural experiment is not complete until it is reported.
- Reporting an experiment is important because;
  - The report acts as a reference document for farmers to improve on their crop production
  - It also assists researchers to know what others have already researched
  - It helps other researchers to comment or question on the results of the findings.

An experimental report must have a scientific perspective following the format as below

1. Title

- This is the heading of the experiment and must be short and clear. i.e,
  - Maize variety trial
  - Response of layers on photoperiod.

2. Introduction.

- An introduction describes an experiment by providing subject, purpose, scope, and plan of development.

a. Statement of the subject

- This defines the title and explains the theory associated with the topic, for example, if the topic is spacing of maize trial, you may explain the general relationship between spacing and yield of maize.
- You may also include the history or current situation of the title e.g. what spacing farmers in the area have been using and how it has affected yields.

b. Statement of purpose

- This describes what you want to achieve by carrying out the experiments and why the experiments are considered as important.

c. Statement of scope

- This describes what the experiment will cover e.g. What spacing will be studied or will you include other variables like effects of spacing on growth rate, maturity or survival percentage.

d. Statement of plan of development

- This provides an outline of various parts of the report and how they will be sequenced i.e. this report covers the objectives, materials, methods of data collection, design the experiments, discussion, results, conclusions and recommendations made.

3. Objectives /Aims

- This provides objectives of the experiments. These objectives must be clear and specific e.g. the aim of the experiment is to find out the best spacing for high yield of MH 12 maize in the area.

4. Materials and methods.

- All the materials used in the experiments and their use or purpose should be included in the report i. e. hoe – used for hoeing.
- Methods include choice of the experimental treatments for example randomization or Latin Design.
- Include husbandry practices and the dates for each practice should be included along side with remarks i.e. 23/01/2011- Fertilizer application: applied muriate of potash at 200kgs/ha using dollop method.

5. Data collection, Analysis and Results.

- All information collected must be categorized where description for each observation must be accurately presented.
- Numerical information should be provided with proper analysis through charts, tables or graphs.

6. Discussion or interpretation

- Each observation, measurement or result should be explained and interpreted.
- You need to show why you think happened as observed. For example if spacing tomatoes at 60cm apart gave the highest yield while spacing at 30cm apart gave the least yield, you should provide the reason for each case.
- It becomes easier to explain and interpret the results if the following observations are recorded:
  - Growth rate.
  - Number of branches.
  - Survival percentage.
  - Pest score and disease incidences.
  - Plant lodging percentage.
  - Leaf colour and leaf number.
  - Number of fruits per plant and fruit size.

7. Conclusion.

- This is the final statement of findings and results.
- It summarises the results by identifying the best treatment and describe its performance .Foe example, of all the varieties tested, MH 12 gave the highest grain yield of 55 bags /ha.

8. Recommendations

- This is the suggestion or advice offered.
- It persuades a leader or a farmer to take a particular action.
- The recommendation must be justified by the evidence from the collected data.
- The recommendation must be supported by interpretation of the data or results.
- It must be sound based on facts not on merit
- It also must be based on conclusions drawn from the observations and results.
- For example you can make a recommendation as follows:
-

Farmers in the area should grow MH12 maize variety which gives high grain yield. This variety is resistant to head smut and plant lodging. The variety responds very well to fertilizers and produces large cobs that are well filled with large grains.

Guide lines for writing a report on an experiment

1. Scientific attitude

- This involves emphasising the facts rather than personalizing them. Do not use words like I, we, our, us, me instead:
  a. Use third person singular or plural active voice i.e.MH12 variety gave the highest yield.
  b. Use the third person singular or plural or passive voice i.e. Urea was applied at 200kg/ha, net plots were harvested separately. Treatments were randomized in each block.

2. Expressing facts accurately

- This means using facts which mean exactly what you want.
- Avoid vague or meaningless words e.g. fair, good.
- Avoid technical jargon (difficult words) i.e. "ceiling to limit", "trigger" for "start".
- Use simple and familiar words e.g. "begin" not "activate", "best "not "optimum".

3. Sentence structure and length

- Use simple and short sentences.
- Vary sentences to avoid monotony.

4. Paragraph structure and length

- A paragraph must contain only one main idea.
- The other sentences in the paragraph develop, support and clarify this idea.
- The main idea is usually stated at the beginning of the paragraph.

UNIT 8: CHALLENGES IN AGRICULTURAL DEVELOPMENT

TOPIC 1: POPULATION GROWTH AND THE ENVIRONMENT

How population growth cause deforestation.

- When population is high there is great
  - need for settlement space
  - need for new farms for cultivation
  - need for forest products for charcoal, timber, poles, and fire wood.
- High population also encourages trading that requires shops, road infrastructure industries, and office blocks which require clearing of trees.
- High population also creates great need for more gazing space to raise more animals to feed more people
- Clearing of trees makes the ground bare which causes serious soil erosion.

Cause-Effect of soil erosion

Rapid population growth

↓

Increased deforestation

↓

Bare ground

↓

Increased run –off

↓

Increased soil erosion

↓

Creation of bare ground, Channels, rills and gullies.

Effects of soil erosion

- Loss of fertile top soils
- Reduction in arable hectarage
- Food insecurity
- Exposure of plant roots due to run –off
- Pollution of water reservoirs due to washing away of chemicals from the agriculture fields.
- Siltation of water reservoirs
- Flooding due to shallowness of water reservoirs as a result of siltation.

- Transmission of soil pests and diseases
- Depletion of water resources due to high speed of run-off and low infiltration rate and also the large population uses more water.

Ways of conserving water

i. **Physical measures of water conservation**
   - Constructing storm water drains which divert water from up land into a natural or artificial water way.
   - Constructing tie or box ridges which help to hold water in furrows, allowing water to soak into the soil.
   - Constructing contour (Ridges across the slope)
   - Construction of dams as an artificial water reservoir

ii. **Biological measures of water conservation**
   - Planting trees and grasses to maintain soil cover
   - Planting close growing cover crops such as groundnuts and sweet potatoes
   - Practice strip cropping to reduce run-off
   - Practicing agro forestry
   - Practicing crop rotation
   - Controlling bush fires
   - Reducing the stocking rate to prevent overgrazing
   - Practicing rotational grazing
   - Practicing family planning to control high population growth hence reducing pressure exerted on land and soil resources

How rapid population contribute to the depletion of water resources

- A large population uses more water.
- The greater the population the greater the deforestation because this large population have a greater need for settlement space, new farms for cultivation, forest products for charcoal, timber, poles and fire wood.
- Deforestation leads to bare land which results into
  - More run-off
  - Low infiltration rate
  - Less ground water
  - Low water table
  - Drought due to low ground water level which reduces the amount of water evaporation or evapo-transpiration to form rain.

Importance of conserving water

- For domestic use
- For crop production
- For Hydro-electric power
- Livestock use
- Fish farming.

TOPIC 2: POPULATION GROWTH AND FOOD SECURITY

A. FOOD SECURITY

- Food security is a situation where there is enough food for everyone at all times
- Food security is made possible when there is food self-sufficiency at household or national level.
- Self food sufficiency means the ability to produce enough food everyone without developing an external sources
- Malawi as a national therefore are needs food self sufficiency at household level as well as national level.
- The increase in the population calls for an increase in the amount of food needed for the entire population

Ways of Attaining Food Self Sufficiency

1. **Improving Farming Technology**
   - Enabling the timely completion of critical farm operations
   - Developing more effective pesticides herbicides insecticides and more efficient way of applying them
   - Enriching soil fertility through proper use of organic and inorganic fertilizer.

2. **Improved Seed Varieties**
   - Resistant to pest and diseases
   - Fast growth
   - Early maturity
   - High yield

3. **Good Land Husbandry Practices**
   - Using each piece of land according to it's capability
   - Conserving the land ensure sustainable development without causing erosion and loss of fertility

4. **Good Improved Seed Varieties**
   - Resistant to pest and disease
   - Fast growth
   - Early maturity
   - High yield

5. **Fair Land Policies**
   - fairness in distribution of available land
   - Land policies which encourage equitable land distribution to help small holder farmer achieve food self sufficiency.

6. **Good Crop Husbandry**
   - Early land preparation
   - Timely weeding
   - Correct manure and fertilizer application
   - Controlling pest and diseases all these are intended at realizing high yield.

7. **Irrigation Crops**
   - This ensures farmers obtain high yield even when there is droughts
   - Enable farmers to grow and harvests more than one a year

8. **Good Livestock Husbandry Practices**
   - Proper feeding, proper breeding, pest and disease control. All these ensures sufficiency milk, eggs, for the family or nation

9. **Fair Pricing Policies**
   - Fair prices for improved seeds, fair prices for pesticides
   - Fair prices for inputs like fertilizer, fair prices for machinery
   - Better prices for food crops so that farmers can be encouraged to grow more and ensure self food sufficiency.

10. **Crop Diversification**
    - Growing more than one crop with one growing season i.e.
      - Mixed cropping
      - Strip cropping
      - Relay cropping
      - Dimba cropping

11. **Mixed Farming**
    - Growing crops and keeping animals on the same farm

Importance

- safeguard the farmer in the invent of crop failure
- give a farmer more balanced diet
- spreading the food supply throughout the year

12. **Encouraging Estate Food Production**
    - Most estate own very good pieces of land in terms of fertility but prioritise for cash crops so to ensure self food sufficiency:
      - Allocate more land for food crops
      - Provide inputs to tenants for food production
      - Train farmers in food crop production

13. **Food Storage**
    - This system helps to reduce spoilage
    - Proper storage of food is critical in food self sufficiency, if it is possible to harvest a lot of food but in the end of the year become not food self sufficiency when that food is not properly stored.
    - Food storage ensures availability of food throughout the year

TOPIC 3: POPULATION AND LAND POLICY IN AGRICULTURE

- Policy is a statement that guides in decision making
- The land policy available now has a greater on agriculture
- The current policy acknowledges free land tenure system in Malawi.
- Land tenure refer to the way in which land is owned in Malawi
- This indicate the right of the people to own, use and control the land and its resources
- The three land tenure system include

1. **Public Land**
   - This is land held and used by the government building roads, forest reserves, national parks and other infrastructure
   - No individual can use this land for personal purposes because the government has control over it.

2. **Communal (Customary Land)**
   - This land is owned and used by tribe or clan and is under the control of a tribal chief or village head man.

Characteristics of communal land

- It is held under customary title
- land is distributed to tribal members by the chief although the chief is not the of the land but just prevent them
- Land is located free of charge and no one can buy or sell it
- The community retains ownership of the land.

Advantages

- Every member is assured of getting a piece of land because it is free.
- there are some security of tenure as the community cannot be evicted

Disadvantages

- It cannot be used as a security for obtaining loan
- Farmers have little interest of improving the land
- It is difficult for progressive farmer to enlarge farm holdings
- It leads to land fragmentation
- It leads to overgrazing since there is no restriction of the number of animals kept.

3. **Private Land**
   - This is held under free hold title and lease hold title and it is registered under private land registration act and this land is owned by an individual under this system.

i. **Free Hold Title**
   - Under this system the individual has complete ownership of the land such as that he/she can use it any way they want as long as it is profitable, this owner pays rent to the government or sometimes not.

Advantages

- A farmer can use it to get loan from the bank because it is his
- a farmer can sell it if he wants
- a farmer can use it for long term investment

2. Lease Hold Title

- This land is held by an individual for a fixed period of 99 years for a specific purpose
- Every year the owner pays rent to the government
- This land has got a title deed

What implication has the land tenure system brought on agriculture in Malawi?

- It is clearly seen that land is not evenly distributed basing on this land tenure system.
- People owning land through private tenure system command large amount of land while those owning land through customary land tenure have very small pieces of land
- This inequitable distribution of land lower agricultural production.
- Private land owners may leave a lot of their fertile land idle while others have nowhere to cultivate
- Those under customary system grow crops continuously on the same small pieces of land and this lowers agricultural production.

The role of population and agricultural policies in national development

- They guide in planning development activities
- They guide in the distribution of agricultural inputs and other services
- Ensures that resources such as land are conserved and population
- To ensure that carrying capacity of the land matches with the growth of population

TOPIC 4: AGRO BASED INDUSTRIES

- An agro based industry is a company/ firm/ factory or any manufacturing facility that uses raw materials from the agricultural sector or manufactures inputs or manufactures chemicals used in the agriculture sector.
- These are several agro based industries that use raw materials from agriculture, such as below.
    - Grain and milling company: It produces gramil, maize mil , bread
    - Rab producers: produces rices into super fire, snow white (ufa woyera)
    - BAT Ltd: produces cigarettes
    - Chibuku products Ltd: produces Chibuku beer
    - Mapeto Wholesalers Ltd: It turns cotton into cotton fabrics (textile)
    - Cold storage Ltd: This uses cattle to produce beef and sausages
    - Malawi dairy industries: They produce fresh milk and yoghurt
    - Illovo Sugar: They use sugarcane to produce sugar and also produce menthylated spirit
    - Ethanol Company: They manufacture ethanol and methylated spirit and also manufacture power.
    - Press food Ltd or Tambala food products
- It f uses chombe tea to make leaves
- Also makes tambala g/nuts
- Also makes super star
    - Capital oil refining industry: It uses sunflower to make Kukoma cooking oil.
    - Lever Brothers: produces cooking oil like Covo, Kazinga and uses g/nuts and cotton seed cakes to make cooking oil.

Agro based industries that produces farm inputs

1. **Agrimal Malawi Ltd**
    - This company manufactures tools such as Ridges, ploughs, cultivators, hoes, matchet/ cutlass/ pangas and hand operated tobacco process (jeke)

2. **Optichem 2000 Ltd**
    - Manufactures 23:21:0 + 45, compound fertilizer e.g. S:15:5:20, Super D : 10:24:20 this company also imports other types of fertilizers e.g. Urea, CAN AND ammonium super phosphate.

3. **Pannar Seed Companies**
    - It produces and supplies hybrid seeds of maize and performance tasted vegetable seeds pannar is also busy distributing

4. **Pipe Company**
    - This company manufactures irrigation pipes, Horse pipes, borehole pumps and spare parts.

5. **Agricultural Trading Company LTD**
    - It supplies knapsack sprayers, pesticides, herbicide, fumigation sheets and other farm implements

6. **Agro Sack Industries**
    - Produces polypropylene bags for seeds, fertilizer and rice

7. **Rab Processors**

- It stocks and sells growers marsh, layers marsh, starter and finishers.

8. Charles Stewart day old chick company

- Distributes hyline layers and Ross broilers chicks

The roles of agro based industries in supporting the growing population

- It produces farm inputs
- produces raw materials from agriculture into finished products
- it manufactures facility that uses raw materials products
- feeding and clothing to the nation
- they provide markets for the farmers produce
- provide employment opportunities
- export some finished products which helps to improve the amount of foreign currency in the country.

TOPIC 5: AGRICLTURE DEVELOPMENT SERVICES

- In order to develop agriculture production that can support the growing population farmers need to have access to agriculture services

Examples of Agriculture Services in Malawi

- Due to increased population growth there is great demand of land that will eventually lead to soil erosion due to continuous cultivation
- Land husbandry services is aimed at promoting sustainable use of the available land resources
- Land husbandry service include
  - Providing guidance and awareness among farmers about the scarce and the vulnerability of the land resources in Malawi.
  - providing relevant knowledge and skills in all aspects of land use and environmental management
  - Encourage farmer to put in place physical and biological soil conservation structures.

Agencies that Provide Land Husbandry Services

- land resources and conservation unit
- agricultural extension staff in ADDs
- land husbandry training centre in Zomba
- environmental education unit in Zomba

Irrigation

- Irrigation schemes under the department of irrigation provide irrigation services so that in the area of erratic rainfall crops can be irrigated to increase crop production

Farm Settlement

- Farmer without land for agriculture are relocated to areas where land with fertile arable land is available

Aims of Farm Settlement

- promotes special crops i.e. cotton and tobacco, maize and G/nuts
- promotes woman participation in agriculture production
- encourage hand capped people i.e. the blind to contribute towards agricultural development
- Improve the spread of improved agriculture practices to neighboring rural communities.

Farm Mechanisation

- While most farmers in Malawi use hand tools and manpower only 13 % of the small holders use animal-drawn implement.
- Farm mechanization involves;
  - Selection, care and management of draught animals
  - Maintenance of implements
  - introducing donkeys as alternative sources of draught animals
  - Training draught animals in ploughing, ridging and cultivating

- providing credit to farmers for buying animal powered machinery
- Ox- training units in ADDs provide these services.

Seed Technology

- Provide good quality seeds that are certified ADMARD, N.S.C.M and lever brothers are responsible for the provision of certified seeds.

Crop Protection

- This minimizes crop losses due to pest, diseases and weeds
- The following services provide crop protection
- Breeding and release resistant varieties by agriculture research
- Establishment of plant of quarantines
- Plant pest chagnostic and advisory serious by agriculture research
- Advising farmers of integrated pest management
- Use of recommended specific pesticides supplied by ADMARC.

Provision of Farm Inputs

- This encourages farmers to use recommended farm inputs provided by
  - Agora, ATC, ADMARC, Norsk Hydro, Optichem, Farmers World
  - Rab processor- for stock feeds
  - Grain and milling company- stock feeds

Soil Testing

- This is done to ensure that the right type of fertilizer is apply
- This is done by research institutions such as Chitedze, Bvumbwe

Agriculture Credit to Small Holder Farmers

- This ensures that farmers have capital which will help them improve their agricultural production credits are providing by MRFC to small holder farmers.

Farm Management

- Agricultural extension workers advise farmers about farm planning and budgeting in order to improve farm production

Food and Nutrition

- To reduce high rate of morbidity and mortality among children and infants a food and nutrition unit has been established in ministry of Agriculture in order to
  - help small holder farmers in food diversification to decrease harvest looses and ensure food security

- establish system of assessing house hold level, food security and early production of short falls
- monitoring the nutrition situation in EPA and ADDs

Extension and Training

- This offer technical information advisory and support to small holder farmers
- Provide training to framers to change their attitudes and improve knowledge and skills
- Strengthen links between researches and farmers.

Technological Innovation and Food Security

- Scientific and technological innovations are fundamental for ensuring food security
- Food security means that every one has access to adequate food at all times of the years.

Technologies that ensure food security may include the following

1. Soil Conservation and Drainage
   - Contour bunds, contour ridges, terrace farming, draining away access water through graded bunds are modern technologies that control soil erosion and have made the land more productive.
2. Plant and Livestock Breeding
   - Breeding plants and crops using new technologies such as due of disease resistant and drought resistant varieties have resulted into high yielding crops and livestock ensuring food security.
3. Irrigation Technologies
   - The use of irrigation i.e. sprinkler and drip has not only ensured efficient utilization of water for crop production but has also been a means of overcoming drought and enabling double harvest
4. Crop Processing and Food Packaging
   - Processing, canning and packaging ensures that food can be kept longer in storage without damaged
5. Food Storage and Preservation Technology
   - This minimizes wastage from pest and moulds e.g. use of silos, cold rooms, deep freezers ensures that food is kept available for long periods
6. Fertilizer production technology
7. Stock food manufacturing
8. Pesticides and herbicides
9. Mechanization

Ways in Which Crops Resist to Drought Conditions

1. **Adapting to Drought**
   - Some crops are better suited to drier condition and are able to grow under very little moisture i.e. cassava and sweet potatoes.

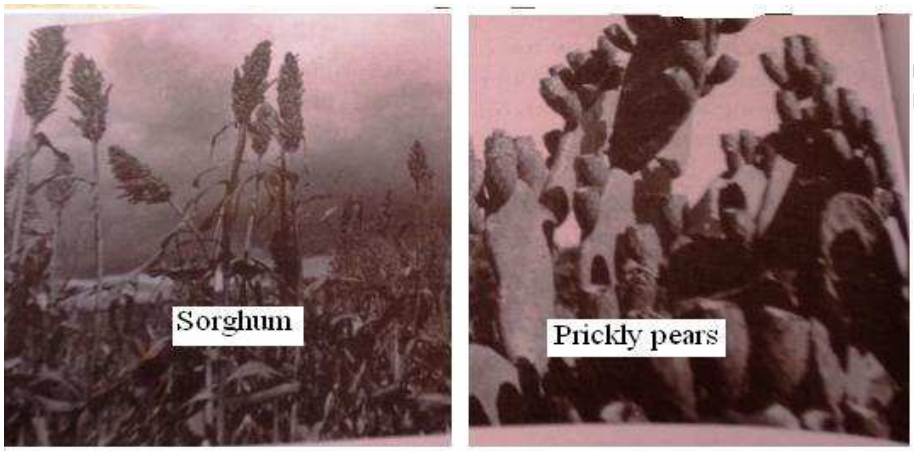
2. **Early Maturing**

- Some crops mature early do not suffer when the growing season is short.

3. **Easy Storage**
   - Crops like cassava and sweet potatoes can be left into the ridge and harvest when needed while millet and sorghum are easily stored when harvested

Importance of growing Drought Resistant Crops

- Ensures that food supply is available even during the times of drought



Drought resistant crops

TOPIC 6: GENDER AND AGRICULTURE DEVELOPMENT

- If every Malawian farmer had opportunity to use improved farming technology yield would be high and agriculture would develop tremendously but this is not the case because women are marginalized (left behind). There is gender bias.
- Gender bias refers to favouritism due to prejudice which results in discrimination against one gender.

Causes of gender bias in agriculture technology

1. Lack of early socialization to technology

- Boys are exposed to technological innovation area in their lives through making or playing with toys while girls are occupied with domestic work or playing with dolls

2. Lack of technological information

- Men are favoured in acquisition of information through free movement, favouring boys in education, more extension workers are men

3. Lack of access to capital

- Culturally male assume that they are heads of the household roles as such they control capital items e.g. cash when a woman earns money she surrender it to the husband such that they cannot buy useful agricultural equipment on their own.

4. Discrimination attitudes and gender stereo type

- Money lender transact
- Business with men than women because women are believed to be peeps without collateral
- Malawian society is seriously prejudiced against women in the use of various type of farm technology. We expect men to drive a tractor, plough the field with ox drawn implement e.g. Ploughs although this has marginalised they are equally capable just like men.
- Lack of confidence, Men generally looks more confident with technological items because they had early association with them since childhood. Women however need only opportunity to develop confidence.
- Lack of exposure to role models
- Many Malawian societies there are very older women in technologically challenging position for young female to copy from, boys often see men Driving tractors or ox-carts. Men are therefore seen using agriculture technologies than women and as such women are regarded as physically and emotionally weak with less drive for independence and control.

Implications of gender bias for agriculture development

1. Low contribution from one gender to agricultural production

- About 50 to 70 % of farming activities are done by women in Malawi but most of these depend on low farm technologies due to gender bias
- Although their involvement is high in farming activities their contribution is low.

2. Low agricultural productivity

- The agricultural productivity of women is limited because of their dependence on unimproved farm technology due to gender bias.
- Agricultural productivity is reduced as same operations may not be completed in time or may not be properly done

3. Food insecurity, starvation and low energy output

- Low yield may lead to food insecurity at household level as well as national level
- Food supply will be inadequate and food self sufficiency can be archived
- The family will face hunger, malnutrition and starvation
- Family farmer will be weak and lack strength to work in the field results in low agricultural development.

TOPIC 7: HIV/AIDS AND AGRICULTURAL PRODUCTION

- HIV/aids is one of the outstanding immerging issues in Malawi that are affecting the agricultural sector negatively depending on the available data there is an increase in the number of new Aids cases from 1990 to 2010.
- The prevalence of the disease seems to be stabilizing because there is a balance between deaths due to HIV/Aids seems to decrease because of the government intervention with ant- literal vital drugs (ARVS) which prolong.

Impact of HIV/AIDS on Agriculture

- Every farmer, farming household farming community and nation has been affected by HIV/AIDS epidemic in one way or the other this has reduced agricultural production and lowered agricultural development in all these areas.
- The impacts include:

1. **Weakening the Labour Force**
   - Aids suffers have low energy levels which reduces their output on agricultural activities because the disease mostly affect the reproductive age group of 15-49

2. **Taking time away from farming**
   - Initially no one in the life has any reserved time to take are for the sick.
   - When a person is suffering from HIV/Aids he/ she as well as other family members who take care of the sick person will use the time that would otherwise be used for farming this results in low yield and show down agricultural development.

3. **Killing the most productive farmers in the population**
   - HIV/Aids kills people in the productive age group 15-49 years
   - Nothing can reduce agricultural development faster than eliminating the very people who cultivate the land.

4. **Depleting Farm Capital**
   - Farming families spend a lot of money on medical drugs in order to prolong life of their beloved one's, this man was not budgeted for sick people but for farm input.
   - Farmers who do not have ready cash may sell some agricultural inputs/ implements to get money for the sick
   - Taking care of the orphans also use farm finances. All these results into low agricultural production.

5. **Disturbing the emotional balance of a farmer**
   - HIV/AIDS has no cure those who get it know that they will die and family members are likely to experience a sense of despair and hopelessness this results in mental breakdown reducing meaningful condition to agriculture and low output at family national level.

TOPIC 8: LAND DEGRADATION AND AGRICULTURE

Effects of land degradation on the economy

- Land degradation in Malawi is becoming worse for several reasons i.e.
  - Land scarcity due to increased population
  - High level of poverty causing people to try to make a living from forest products and poor farming methods
  - Deforestation
  - Soil erosion
  - Overstocking
  - Overgrazing
  - Water pollution
  - Mono cropping
  - Cultivation of marginal lands

Effects of land degradation on the environment and economy

- The increase in human population causes great pressure on land resources for housing cultivation and industrial development.
- Cultivation of more lands makes reduction in the available land for other uses such as animal grazing and forest reserves.
- Over cultivation of land leads to loss of soil fertility and soil erosion and this makes the land become less productive through lowering of agriculture produce.
- Development of gullies due to erosion, take up some of the land and make farming difficult.
- Developing Projects for reclaiming land which has been degraded is very expensive.
- The practice of growing crops on the same piece of land yearly leads to soil exhaustion which requires a lot of fertilizers which is expensive.
- Soil erosion leads to a loss of top soil and plant nutrients resulting in poor quality crops and low yields.
  - **NB:** Economic value estimate by National Environmental Action Plan stipulates that soil erosion accounts for a Loss of K1155 million.
- Low crop production affects the health and lives of both people and livestock which leads to illness, starvation and even death.
- Low crop production also leads to low production of livestock which is an economic loss to farmers and the country as a whole.
- The countries foreign earnings will also be affected negatively because farmers are unable to produce more crops and animals for export.
- High increase in water pollution through accumulation of agricultural chemicals such as fertilizers and pesticides may cause fish and people to be poisoned. The contaminated water may cause some diseases e.g. diarrhea in some people who drink the water especially in rainy season.
- Siltation of water reservoirs also reduces transport and recreation on the rivers and lakes of Malawi.
- Water resource degradation also results in reduced fish production.

REFERENCES

Brady, C.N (1974) *The Nature and properties of Soils*.(8th edition)MacMillan publishing Co. Inc.,34 New York.

Kanjala, B.M. and Kaperemera, N.T (2005) *Strides in agriculture, Book1*. (5th Impression)Longman, Malawi

Kanjala, B.M. and Kaperemera, N.T (2005) *Strides in agriculture, Book2*. (3th Impression)Longman, Malawi

Kanjala, B.M. and Kaperemera, N.T (2005) *Strides in agriculture, Book3*. (3th Impression) Longman, Malawi

Kanjala, B.M. and Kaperemera, N.T (2009) *Strides in agriculture, Book4*. (10th Impression) Longman, Malawi

Ngugi, D.N; Karau P.K,:Mguyo(1990) *East African Agriculture* (3rd edition),MacMillan Kenya.

Sakira,W.A. (1981*)"O " Level Agriculture*.(20 th Impression) Longman.