TOPIC 1: SOIL DEGRADTION

- Soil degradation is the loss or decline in the quality and productivity of the soil.

Figure 1.1*: Degraded soil.*

Forms of soil degradation

1. Physical degradation

- It leads to loss of soil fertility and poor appearance

Main causes of physical degradation

(i) Soil erosion

Types of soil erosion

(a) Wind erosion

- Wind is a natural agent of soil erosion
- Wind erosion occurs when soil that is not covered with vegetation is blown away by strong winds and deposited in a different place
- It leads to the removal of the top fertile soil thus reducing fertility of the soil
- This mostly occurs during dry season because soil has been burnt with the sun and has become loose

(b) Water erosion

- Water is the main agent of soil erosion in Malawi.
- Water erosion occurs when soil particles are washed away by runoff water and are deposited in a different area

Forms of water erosion

A. Splash erosion

- It occurs when raindrops hit the surface of the earth that has no vegetation cover.
- The impact of the raindrops on the soil surface causes the soil to be detached leading to destruction of the soil structure

B. Sheet erosion

- Sheet erosion is the uniform removal of top soil by running water
- It usually occurs on sloping land

C. Rill erosion

- Rill erosion is the removal of soil by water running through small channels known as rills.
- The runoff water forms small channels as it goes down the slope

D. Gully erosion

- This is the removal of soil by water where the small channels from rill erosion develop into gullies.
- Gullies are wide and deep
- Soil carried away through gully erosion is usually deposited in water reservoirs, e.g., streams, dams, rivers
- Gullies hinder the cultivation of land

(ii) Physical deterioration

- Physical deterioration occurs when the soil structure is destroyed by heavy machines
- The soil particles that have been broken down are eroded by wind or running water.

Fig.1.2: *Heavy machinery destroy soil structure*

2. Chemical degradation

- Chemical degradation leads to loss of soil fertility, soil pollution, loss of soil nutrients or organic matter, reduction in soil pH and an increase in soil salinity

Causes of chemical degradation

(i) Use of chemical fertilizers
- ✓ It leads to acidification of the soil thus lowering the soil pH

(ii) Excessive salts in the soil
- ✓ It leads to an increase in soil salinity which prevents water from reaching the roots of the plants

(iii) Industrial wastes, oil spills and excessive use of insecticides and herbicides
- ✓ They lead to soil pollution
- ✓ They lead to acidification of the soil
- ➢ The soil then becomes too toxic leading to degradation

(iv) Loss of soil nutrients or organic matter
- ✓ This lowers the fertility of the soil

3. Biological degradation

❖ This is the loss of biodiversity and organic matter due to erosion or pollution leading to reduction in soil functions such as drainage and aeration

Agents of biological degradation

(a) Human beings
(b) Animals
(c) Microorganisms found in the soil

Causes of biological degradation

- Poor cultivation practices
- Deforestation
- Overstocking
- Overgrazing

General causes of soil degradation

1. Overgrazing

❖ This is the practice of keeping large numbers of livestock on a small piece of land
- It leads to the destruction of grass and other vegetation leaving the land bear resulting into soil erosion

2. Monocropping

❖ This is the practice of growing a single crop on a large area of land year after year
- It leads to build-up of pests and diseases in the soil
- Specific nutrients are also reduced in the soil since the crops use up same nutrients every year.
  - ➢ This leads to destruction of the soil structure

3. Poor cultivation practices

- Poor cultivation practices, e.g., ploughing along the slope lead to an increase in soil erosion
- The use of heavy machines during cultivation leads to destruction of soil structure

4. Excessive use of chemicals

- Excessive use of chemical fertilizers and pesticides lowers the soil pH
- The land is therefore bare leading to an increase in soil erosion

5. Deforestation

❖ Deforestation is the practice of cutting down trees for fuel or to create land for settlement and cultivation

- The land is left bare thus exposing it to soil erosion

6. ***Irrigation and soil drainage***
   - They can lead to soil acidification and salinization

7. ***Industrial pollutants***
   - Heavy metals destroy the chemical composition of the soil

Effects of soil degradation on crop production

1. ***Loss of fertile soil***
   - Topsoil contains humus which makes it fertile
   - Soil degradation leads to a reduction in soil fertility through soil erosion

2. ***Reduction in arable land***
   - Soil erosion leads to destruction of soil structure
   - The land is left fallow
   - Formation of gullies leads to wastage of huge tracts of land

3. ***Spread of water-borne diseases and soil-borne diseases***
   - Soil that has diseases is carried to areas where the soil is healthy thus contaminating such areas

4. ***Famine***
   - Reduction in arable land leads to less crop production leading to famine and food insecurity

5. ***Silting***
   - Eroded soil particles are deposited in water reservoirs
   - This leads to reduced water levels in the reservoirs

6. ***Pollution of water sources***
   - Soil deposited in water reservoirs contain fertilizers, industrial wastes and pesticides which causes pollution of water resources
   - The contaminated water used in irrigation leads to reduction in crop yields or loss of crops

7. ***Flooding***
   - Lack of vegetation cover makes the soil susceptible to flooding.
   - Floods destroy crops leading to crop failure

8. ***Desertification***
   - It reduces purity of air since there are fewer vegetation to purify the air
   - This makes people to have health problems reducing the workforce that could be used to cultivate the crop land
   - This leads to food insecurity and rampant cases of malnutrition

9. ***Inadequate water during dry periods***
   - Due to surface run-off and low water infiltration lowering the water table

10. ***Dust storms***
    - This is as a result of wind erosion particularly in overgrazed areas and where tillage is done during dry periods

11. ***Reduced carbon storage in the soil***
    - Conversion of forest into cropland significantly reduces the amount of carbon dioxide storage in the soil
    - It is also done by changing the composition and structure of the soils through agriculture

Relationship between rapid population growth and soil degradation

1. ***Overcultivation***
   - High population growth rate leads to Overcultivation of the land left after settlement to feed the growing population
   - This lead toss of soil fertility

2. ***Deforestation***
   - High population growth rate leads to clearing of a lot of forestry land for human settlement
   - This leads to reduction in natural vegetation resulting in soil erosion

3. ***High demand for wood fuel***
   - An increase in the population leads to an increase in demand for fuel increasing rate of deforestation
   - This leads to soil degradation

4. ***Industrialization***
   - High population growth rate leads to establishment of many industries to provide employment for the growing population
   - The wastes from the industries are deposited into rivers and other water bodies
   - The water is then used for irrigation causing soil pollution

Ways of controlling soil degradation

1. ***Afforestation and reforestation***
   - Afforestation is the planting of trees where they did not exist before
   - Reforestation is re-growing or re-establishing of trees in areas that once had trees which were removed
     - This will help to reduce water and wind erosion
     - It will also improve the soil structure

2. ***Good farming practices***
   - They reduce soil erosion
   - They maintain the soil structure
   - They restore soil nutrients
   - They replenish lost soil nutrients

3. ***Mulching and planting cover crops***
   - Mulching is the process of covering the ground surface with materials such as plant residues, manures and plastic sheets.
   - Cover crops are crops that are grown to protect the ground from wind and water erosion.
     - They help to conserve soil and water

4. ***Proper disposal of industrial wastes***
   - Chemical waste from industries should be disposed of properly and not in water
   - This will reduce water pollution which in turn will reduce soil pollution

5. ***Controlled use of chemicals***
   - The use of chemical fertilizers and pesticides should be reduced to prevent acidification of the soil
   - Acidic soils should be restored through liming

TOPIC 2: AGRICULTURE AND CLIMATE CHANGE

- Climate change is the alteration of long term weather patterns

Ways of dealing with climate change

1. **Conservation Agriculture (CA)**
   - Conservation agriculture refers to the resource saving agricultural production that strives to achieve acceptable profits together with the high and sustainable production levels while concurrently conserving the environment.
   - It is based on enhancing natural biological processes above and below the ground

Practices or principles involved in conservation agriculture

a. *Minimum soil disturbance*
   - This refers to the process whereby mechanical cultivation or disruption of the soil is reduced in order to maintain soil nutrients, minimize soil erosion and conserve water in the soil

b. *Planting and maintaining soil vegetative cover*
   - This is an aspect of soil management that helps to preserve the top soil against the agents of soil erosion
   - It leads to an increase in soil living organisms and their activities which result in build-up of organic matter in the soil to provide relevant nutrients
   - The soil cover helps to prevent soil erosion

c. *Crop rotation*
   - It refers to the practice of changing crops in the plots each season

- It helps in controlling pests and diseases by preventing their build-up which is caused by Monocropping
- It helps in reducing weeds in the farm
- It improves soil structure and porosity which improves soil drainage and water holding capacity

Conservation Agriculture and climate change

- Practicing conservation agriculture ensures that agricultural farming systems are flexible to the climate
- It also causes a drastic drop in the emission of greenhouse gases that lead to climate change
- Reduction in greenhouse gases ensures that temperature levels are maintained, thus controlling climate change

2. Water harvesting

- Water harvesting is the process of collecting rain water and storing it for proper use.

Ways of water harvesting

i. Collecting it from a roof of a building

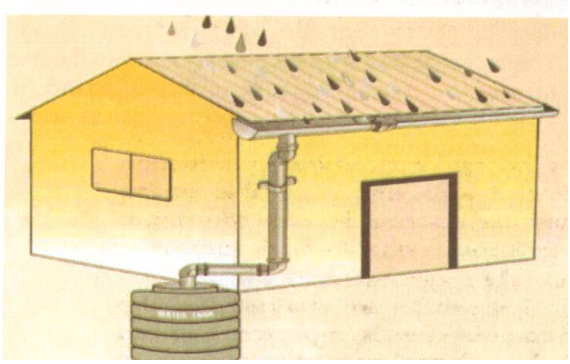


Fig.2.1

ii. Collecting run-off in local water catchment areas

iii. Directing water from a flooding river to a dam or storage system

Uses of harvested water

- For irrigation
- For industrial activities
- For domestic use, e.g., cooing, drinking, washing

❖ Water to be used for cooing or drinking should be purified.

Importance of water harvesting

- It helps to reduce soil erosion from run-off
- It is a source of water supply during dry periods
- It ensures that the water demand in areas with inadequate water supply is met
- It helps to mitigate the flooding in low lying areas
- It reduces demand on wells which may lead to ground water to be sustained

Water harvesting and climate change

Massive deforestation has led to climate change. As a result there have been frequent occurrences of droughts and floods. Water harvesting will help farmers collect rainwater during the rainy periods or when there are floods and use it for agricultural production during dry periods or when drought occurs through irrigation.

3. Agroforestry

- Agroforestry is a practice where trees or shrubs are grown on the farms or in pasture land
- Examples of recommended trees for agroforestry in Malawi are Msangu (***Faidherbia albida***), Mthethe (***Acacia polycantha***) and Nkunkhu (***Acacia galpinii***)

Fig.2.2

Importance of agroforestry

- It is aimed at ensuring that farmers benefit from trees and crops
- It also ensures that crops and trees benefit from each other
- It creates a sustainable environment that can support a wide variety of birds, insects and animals which may be beneficial in agricultural production

Agroforestry and climate change

- Trees can act as a source of income to farmers since they can be sold as timber or wood
- Trees are also a source of wood fuel needed in most homes for cooking
- Agroforestry reduces deforestation, thus reducing global warming too
- Trees also protect crops from excess temperatures by providing a cool atmosphere
- If leguminous trees are planted alongside crops, they fix nitrogen into the soil.
- Leaves and branches that are pruned from the trees act as mulch and conserve the soil which helps to restore soil fertility and increase organic matter content
- Agroforestry helps to conserve soil and water by mulch for the soil and also reducing the speed of wind and run-off which causes soil erosion
- Nutrients are thus maintained in the soil leading to an increase in crop production.

Systems of agroforestry in dealing with climate change

(a) Parkland

- Parklands are visually defined by the presence of trees widely scattered over a large piece of agricultural plot or pasture
- The trees are usually of a single species with clear regional favourites

Benefits of Parkland

- The trees offer shade to grazing animals
- The trees protect crops against strong wind bursts
- The trees provide prunings for firewood
- The trees are a roost for insects or rodent-eating birds

(b) Alley cropping

- Alley cropping is where crop strips alternate with rows of closely spaced trees or hedge species
- Trees are pruned before planting crops

Benefits of alley cropping

- The cut leafy material is spread over the crop area to provide nutrients for the crop
- The hedges serve as windbreaks and eliminate soil erosion

(c) Strip cropping

- Strip cropping is where trees or shrubs are planted in wide strips
- The benefits can similar to those of alley cropping
- Trees grown in strip cropping provide fruits, nuts , etc

4. Reforestation

Reforestation is the planting of trees or re-establishing of forests in an area that had trees which were then cut down

Ways of reforestation

a) Natural ways
   - ➢ Forest cover is allowed to re-grow

b) Artificial way
   - ➢ Actual planting of trees in areas that have been depleted through deforestation

Importance of reforestation

- It helps to improve the quality of human life by absorbing pollutants and dust from the air
- It restores the natural habitats and ecosystems
- It is a key for reversing global warming since trees balance the amount of carbon dioxide available in the atmosphere

Reforestation and climate change

- Plants absorb carbon dioxide through photosynthesis and thus eliminate the greenhouse gas from the air

➢ Plays a role in global warming carbon cycle

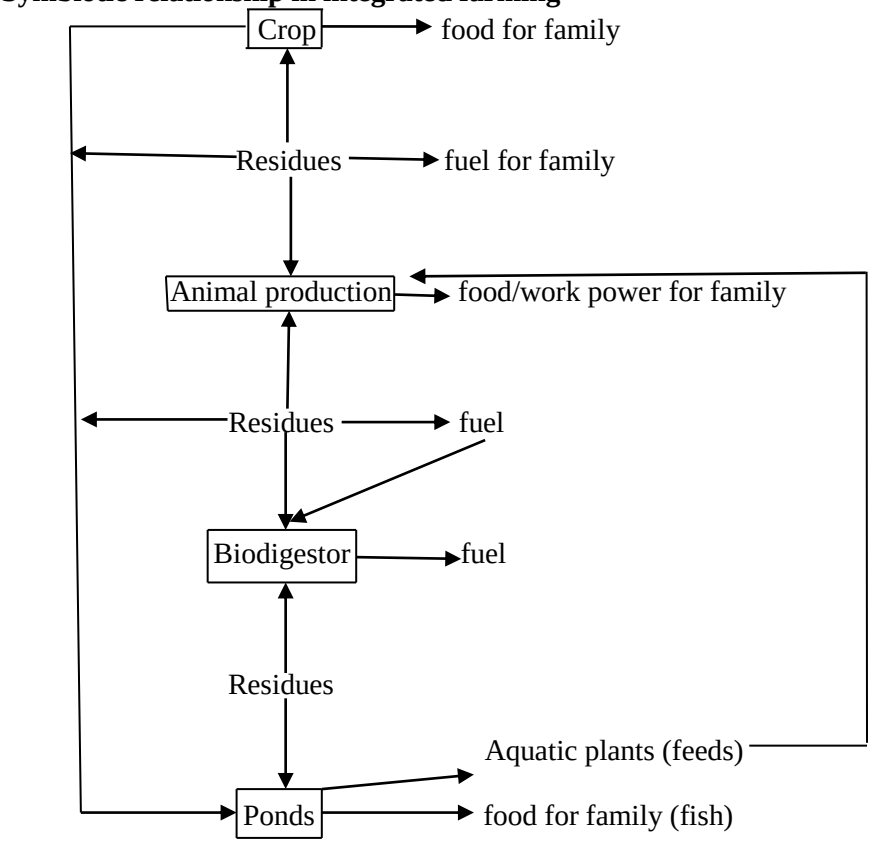
- Forests serve as natural carbon sinks
- Through reforestation, carbon emissions are offset from the air and this helps to fight climate change

5. Integrated farming

- Integrated farming is a type of farming system where crops are grown with trees; livestock are kept and fish production are practised
- It is also referred to as integrated forest, crops, livestock and fish production

❖ The aim is to create symbiotic relationship in the ecosystem

Symbiotic relationship in integrated farming



Integrated farming and climate change

The integrated of the forest, crop, livestock and fish farming helps in dealing with climate change

- Trees help in reversing climate change by absorbing carbon dioxide from the atmosphere thereby reducing global warming
- Wastes from crops and by-products of crops are used as livestock feed
- The water that is drained from the fish pond is recycled and used for irrigating crop fields
- Feaces and urine from livestock are used as Farmyard manure to improve soil fertility for crop production or to generate biogas for domestic use, e.g., cooing, heating and lighting
- In case there is a slaughterhouse on the farm, the blood mixed with water obtained from slaughtering animals is channeled into the fish pond
- Aquatic plants growing in the fish pond can e removed and used as feed for livestock

TOPIC 3: LAND DRAINAGE

❖ Land drainage is the removal of excess/superfluous water from the soil.

Situations that require land drainage

- When the water table in the soil is high
- When excess surface water is unable to infiltrate or subsurface water is unable to percolate

Importance of land drainage

- It enables human beings to reclaim land from low-productivity areas, e.g., swamps, marshes and waterlogged areas for agricultural use
- It helps to improve a particular area and increase its efficiency and productivity when used for crop production
- It reduces pollution and accumulation of chemicals and industrial wastes in water
- It reduces the spread of water-borne diseases
- It facilitates entry and circulation of air in the soil
- It makes the soil easy to work with
  - ➢ Soils that contain excessive water stick to farming implements
- It helps to prevent flooding

Methods of land drainage

1. **Surface drainage**

- This is the removal of excess water from the surface to restore land for crops and pasture
- It helps to remove stagnant water from the land surface
- It operates through gravity (follows the slope off the land)

Types of surface drainage

a. Open drains or ditches

- It includes use of open trenches or drains
- Open trenches drain the water into deeper drains where the water is collected

Fig.3.1

Qualities of good open drains

- ✓ The channels should, if possible, be covered to ensure safety
- ✓ The depressions should discharge runoff water appropriately
- ✓ The channels should e leveled so that they can collect and remove the water

b. Bedding system or grassed waterways

- It is practised in fields where crops are grown
- In permanent pasture, the beds should e wider
- It is made through ploughing
- The bed should have a high slope at the end to lead the excess water to the waterways
  - Collecting beds at the end lead the excess water to the desired location

Fig.3.2

2. **Sub-surface drainage**

- This is the removal of water below the land surface
- It is done through use of
  - ✓ open ditches
  - ✓ network of pipes
  - ✓ ceramic tiles
- The system consists of perforated plastic pipes that are laid into the trenches which are dug in the ground

- Small stones are aligned over the pipe and the drain in the trench
- Tiles may also be used instead of plastic pipes

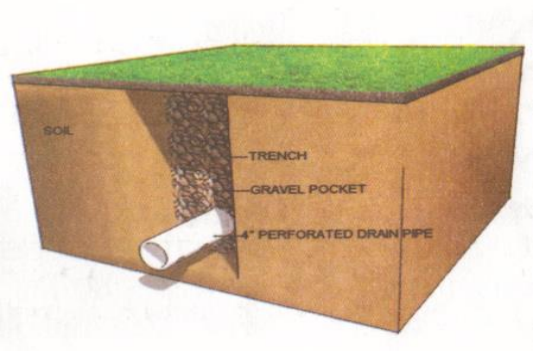


Fig.3.3

Importance of using plastic pipes for sub-surface drainage

- They are light, hence are portable
- They are film
- They elastic

3. Bio-drainage

- This is the removal of water from the soil surface by growing crops
- It helps to reclaim
  i. Salt affected land
  ii. Waterlogged soils
- Deep rooted plants are planted so that they can use up the excess water available in the soil
- The water is then lost from the leaves
  i. through transpiration
  ii. seepage through waterways created by the roots
- Fast growing tree species, e.g., Eucalyptus are usually used
  - ➢ They require a lot of water for growth
- It creates more land for crop growth and improve the nutrients uptake in the soil

TOPIC 4: FARM MECHANIZATION

- ❖ Farm mechanization is the use of equipment, implements and other machines to perform various tasks on the farm in order to improve the productivity
  - It increases farm output and farm worker productivity
  - Machines substitute human and animal power in agricultural production

Types of farm machinery

1. Cultivators

- ❖ These are machines used for ploughing the land

Primary tillage machines

- These are machines used for first breaking of the land

(i) Ploughs

Tasks performed by a plough

- ✓ Crushing the soil into fine particles
- ✓ Aerating and loosening the soil
- ✓ Mixing organic matter in the soil
- ✓ Killing weeds and pests by exposing them to the sun's heat

Types of ploughs

(a) Mouldboard plough

- This is an implement which cuts and turns furrow slices
- It is either mounted or trailed by a tractor or draught animals
- Mounted ploughs are recommended as they can be controlled by hydraulic system in the tractor

Fig.4.2: Achievers pp24

Parts of a mouldboard plough and their functions

- ✓ *Share*
  - Makes horizontal cut in the soil and initiates inversion of the furrow slice
- ✓ *Mouldboard*
  - Inverts furrow slices thus covering surface vegetation completely

- ✓ *Landside*
  - Stabilizes the plough
  - Absorbs the side forces created when furrow slice is turned
- ✓ *Disc coulter*
  - It makes a vertical cut into the soil to separate the furrow slices from the unploughed land
  - It helps to cut the trash which may prevent the share from going deep into the ground
- ✓ *Skim coulter*
  - It removes any trash from between the furrow slices
- ✓ *Frog*
  - It connects the share , mouldboard and the landside to the frame
- ✓ *Heel iron*
  - It carries the weight of the plough at the back
- ✓ *Tail piece*
  - It facilitates the turning of the furrow slice
- ✓ *Beam*
  - It is a metal frame on which all other parts are attached
  - Its weight increases the penetration depth of the plough
- ✓ *Furrow depth wheel*

  It controls depth of ploughing

Maintenance of a mouldboard plough

- ✓ Lubricate the rotating parts of the plough, e.g., wheel bearing
- ✓ Keep shares tight and sharp
- ✓ Keep nuts and boats tight
- ✓ Coat the plough with a rust preventative substance when storing it over a season

(b) Disc plough

- This is a plough that has a heavy steel concave disc about 60-70cm in diameter which carries out similar functions as the mouldboard and share
- The disc plough does not produce completely inverted furrows or bury trash and weeds as the mouldboard does

Fig.4.1

Parts of a disc plough and their functions

- ✓ *Hitch mast*
  - It is an attachment for the three point hitch made up of two side links and a top link connected to the hydraulic system of a tractor for the lifting and pulling of ploughing discs
- ✓ *Beam*
  - It provides attachment for all other parts of the plough
  - It adds more weight for better plough depth penetration
- ✓ *Discs*
  - They are concave in shape
  - They cut and invert the furrow slices
    - Each disc rotates independently
- ✓ *Scrappers*
  - They are located close to the concave surface of the disc
  - They are used to remove trash and mud or soil which may cling on the discs and interfere with penetration
- ✓ *Depth wheel/furrow wheel*
  - It controls the depth of ploughing
  - It helps in balancing the whole implement
- ✓ *Standards/hangers*
  - They connect the discs to the main beam
  - Their hubs allow the discs to rotate

Maintenance of a disc plough

- ✓ Keep the disc bearing clean and properly adjusted

- ✓ Lubricate the bearing as instructed in the operators manual
- ✓ Check plough adjustment if the steering is hard
- ✓ Coat disc blades with rust preventive substance or used engine oil
- ✓ Repair broken blades with special welding electrodes
- ✓ Constantly check for loose nuts and bolts and tighten if necessary
- ✓ Ensure that the angle of cut of the blade has been correctly adjusted

(c) Chisel plough

Fig.4.2

- It has narrow and double ended shovels that are mounted long shanks
- It is used to get deep tillage with minimal soil disruption
- It is used to break soil that is hard and dry (hardpans)
- It does not turn the soil over

(ii) Rotary tillers/Rotary shredder/Rota beater/Hammer knife/Rotary cultivator

- It works on the principle of high speed removing blades or hammers which beat and cut the soil together with trash
- It is does work of both primary and secondary cultivation

Fig.4.3

Maintenance of a rotary tiller

- ✓ Grease the depth wheel, rotor bearing and depth adjuster
- ✓ Check the oil level in the gearbox daily and weekly for the chain
- ✓ Straighten bent blades or replace them as needed
- ✓ Ensure that the bolt holding the blades are always tight
- ✓ Keep the correct chain tension

(iii) Tractor-drawn ridgers

Fig.4.4

- They are used for creating ridges for crops
- They heap up soil on the sides of the ridge
- They can also be used to create channels for irrigation purposes

(iv) Sub-soilers

Fig.4.5

- These are similar to chisel the plough but are heavier and stronger
- They are used to penetrate the soil to a depth of 50-90cm

Uses of sub-soilers

- Bursting up the sub-soil
- Improving soil drainage
- Aerating the soil by breaking the hardpans and clods

- Removing deep rooted weeds due to their penetrating ability

Maintenance of sub-soiler

- ✓ Checking worn out or broken parts frequently and replacing them if necessary

Secondary machines

Harrows

Uses of the harrows

- Levelling the seedbed
- Crushing the clods
- Stirring the soil
- Destroying weeds
- Covering the trash in the soil
- Incorporating manure or organic matter with soil
- Covering broadcast seeds

Types of harrows

(a) Disc harrow

Fig.4.6

- They are either plain or notched
- Plain harrows have smooth cutting edges on their discs
- Notched harrows have grooves in the cutting disc plate
- Harrows comprise a number of sets of gangs of concave discs which can be set at variable angles to the direction of movement
- A gang is an assembly of discs all rotating together with a common shaft or bolt through their centres
- It turns and breaks down all soil surfaces
- It mixes the plant remains into the soil
- It is suitable for use on light soil

(b) Spring tine harrow

Fig.4.7

- This is the spring steel with replaceable still digging points
- It similar to the chisel ploughing shape but is not heavy
- The vibrating tines break the soil clods while the frame tends to level the ground
- It can be used for shallow work
- It is convenient for inter-row cultivation
- It can be used for weeding
- It crushes the soil
- It is ideal for incorporating soil chemicals

(c) Spike tooth harrow

Fig.4.8

- It is mounted on either heavy metal or a wooden frame
- It has spikes which resemble the chisel
- It is useful in preparing a fine level seedbed
- It is pulled by a tractor

(d) Zigzag harrow

Fig.4.9

- The tines are arranged in a zigzag manner
- It works as rigid spike tooth harrow

Maintenance of harrows

- ✓ Clean after use
- ✓ Replace or tighten loose parts, e.g., missing pins, nuts and bolts
- ✓ Welding broken frames
- ✓ Replacing broken blades, springs and spikes
- ✓ Lubricate moving parts
- ✓ Grease the disc bearing daily when in use
- ✓ Coat with oil after a work season to prevent rust

2. Planters and seeders

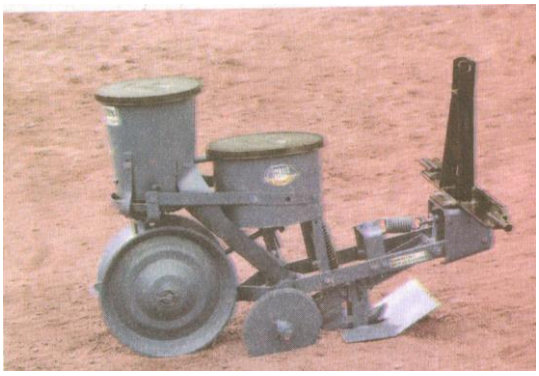


Fig.4.10a

Fig.4.10b

- ❖ These are machines that are used for sowing or planting seeds in cultivated fields
- ❖ ***Planters*** are also known as ***drillers***
  - Planters consist of two boxes called hoppers, carried on wheels, from which seeds and fertilizers are discharged through feed mechanism
  - *Feed mechanism* is the method through which seeds are dropped on the ground from the planters
  - The seeds pass through a delivery tube into shallow furrows made by coulters
  - A coulter is an iron implement which cuts furrows in which the seeds and fertilizers are dropped.
  - The depth of the furrow can be adjusted by adjusting the coulters.
  - The coulters are lifted off the drive at the end of the run to cut off the feed mechanism and prevent seeds and fertilizers from dropping
  - The press wheel then covers and presses the seeds into the soil

Maintenance of the planters

- ✓ Greasing and oiling the movable parts should be done regularly
- ✓ The bolts and nuts should be checked to ensure they are tight
- ✓ The planters should be cleared and coated with an anti-rust substance after the sowing season and before storage

3. Sprayers

- Sprayers are machines for spraying liquids on crops or animals
  - ➢ water mixed with chemicals for pest and parasite control in crops and animals respectively

Types of sprayers

(a) Hand syringe knapsack sprayer

Fig.4.11

- They have a double acting syringe system which allows for continuous output of liquids in droplets when spraying crops or animals
- They are economical
- They are tedious
- They are slow
- The rate of work is dictated by the speed of pumping and walking pace of the operator

(b) Hydraulic sprayer

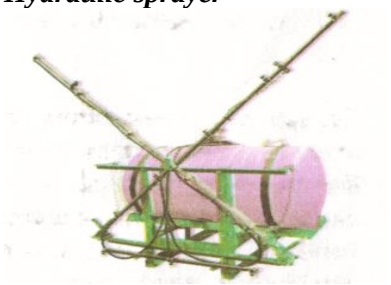


Fig.4.12

- They are more expensive compared to hand sprayers
- They are less tiring to operate and can be used on large farms, e.g., coffee plantations and orchard
- A sprayer boom can be attached to the sprayer to increase the rate of work when spraying crops on large farms
- A boom has more than one nozzle attached to it

(c) Tractor operated sprayer

Fig.4.13a

Fig.4.13b

- This is a tractor operated sprayer
- It consists of
  - i. a tank for holding the chemical
  - ii. a pump for providing pressure to spray
  - iii. a boom for holding the nozzles which release thin films of the chemical
- A boom holds nozzles at a suitable distance
- Nozzles can either be at a fixed or varied lengths if carried by a number of people along the tractor

Maintenance of sprayers

- ✓ Clean and wash all parts after use
- ✓ Store the sprayer in a clean dry place
- ✓ Ensure that nozzles are clean and that all openings are not blocked
- ✓ Always filter off all dirt in the spray-liquid as it can easily block the nozzles

4. Harvesting machines

- These are simple hand tools or animal-drawn or tractor-drawn implements

Common machines for harvesting

(a) Forage harvester

Fig.4.14

- A forage harvester is a machine-driven implement mainly used to gather forage
- It cuts, chops and loads the fodder onto a trailer

(b) Combine harvester

Fig.4.15

It is used for

- Cutting the crop and ramming the grains
- Threshing of grains
- Cleaning and winnowing the grains
- Packing the grains

Parts of a combine harvester

- *Cutter bar*
  - It has a set of knives
  - It cuts the grains
- *Elevator*
  - Channels the cut heads into the threshing drum
- *Threshing drum*
  - Shells grains from cobs or removes husks from wheat grains
- *Outer bar assembly height*
  - It gives the height at which the harvesting is done in relation to the round level
  - It also determines the amount of straw to be handled at the set speed
- *Pick-up reel*
  - It should be set to assemble the heads, cut and feed them into the conveyor chute
- *Straw walker*
  - It separates the grains from the straw
- *Grain sieve/fan*
  - It removes the grains from the chaff

(c) Potato lifting plough

Fig.4.16

- A potato lifting plough is composed of a flat share fitted with steel prongs which furrow and lift the tubers from the soil
- The tool bar depth wheels controls the depth
- The lifting tools must be set to run exactly along the centres of the rows

(d) Potato digger

Fig.4.17

- It consists of broad share behind which rises a metal elevator chain with parallel links
- The soil is shed off through the chain web, and the potatoes are delivered at the rear of the machine

(e) Sheller

Fig.4.18

- It is used to shell maize
- It is a machine used to remove the grains from the cob
- They are either power driven or hand operated
- Some power driven maize shellers are fitted with fans for cleaning, and a sieve for separating the grains from the husks and pieces of cobs

Maintenance of harvesters

- ✓ All the guards, plates, bolts and nuts should be in place and fitted correctly before doing any work with the machines
- ✓ Lubricate moving parts
- ✓ Store under shade
- ✓ Cutting edges should be sharpened regularly
- ✓ Apply oil for long storage
- ✓ The machine should be cleaned regularly to remove straw an chaff that have been deposited in the engine, around the belt and the grain sieve

5. Milking machines

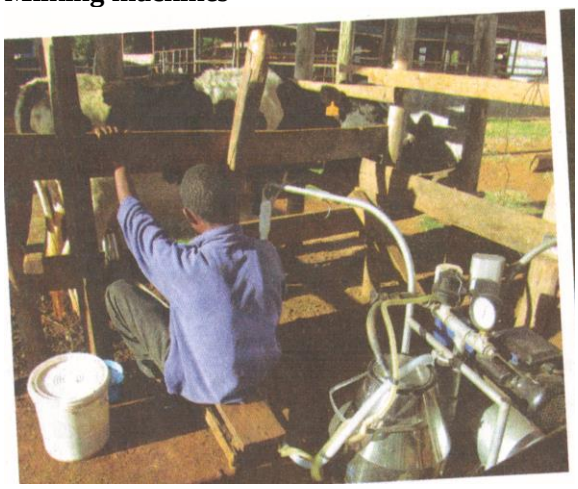


Fig.4.19

- These are machines that are used by farmers during the milking process
  - It is used to extract milk in livestock, especially cows, using a vacuum
  - The milk is then deposited in a container
  - The machine causes minimal damage to the teats
  - It makes the milk free from dangerous pathogens and microorganism
  - It also reduces the occurrence of mastitis in cows

Maintenance of milking machines

- ✓ The vacuum regulator should be checked constantly to ensure that it is operating properly
- ✓ The pipes should be checked regularly to ensure that no air is leaking through them
- ✓ Clean the machine and vacuum regulator always
- ✓ Service the machine after every six months

Factors to consider when mechanizing a farm

1. Size of the farm holdings
   - ➢ It is economical in large tracts of land
2. Costs of farm mechanization
   - ➢ Machines are expensive to install and maintain
3. Efficiency and speed of the machines
4. Availability of skilled and qualified personnel
   - ➢ It requires skilled and qualified personnel to operate most machines
5. Topography
   - ➢ It is easier done in fairly gentle slopes to relatively flat land
6. Accessibility of the land
   - ➢ The land should be accessible for easy movement of machines
7. Support services
   - ➢ Availability of spare parts for maintenance of machines, fuels and oils
8. Value of the crop
   - ➢ The crop should be of high value in order to recover the costs of mechanization
9. Market demand
   - ➢ There should be high demand for the crops that are to be planted under mechanization
10. Availability of labour
    - ➢ If labour within the farming community is plentiful and cheap, the level of mechanization may be low and its opposite is also true
    - ➢ It is important to avoid unnecessary seasonal labour surpluses and shortages
11. Land tenure system
    - ➢ Customary land tenure may limit the introduction of mechanization on the farm because
      - ✓ Of lack of security
      - ✓ It could prevent farmers combining farms to create a bigger farm holding
12. Farming practices
    - ➢ Traditional farming practices have low productivity and profitability

- ✓ This may limit the size, level (scale) and efficiency of mechanization to be used on the farm

13. Farmer's attitude
    - ➢ Farmers should have positive attitude towards mechanization
14. Land for animal feed
    - ➢ Where animal-drawn implements are used, there must be sufficient land for pasture production
15. Availability of improved infrastructure and social amenities
    - ➢ Farm mechanization requires well distributed road network, widespread electrification, water system and well-structured marketing channels for various products

Advantages of farm mechanization

- The speed of operation is faster and more work output achieved
- The machinery can be controlled to prevent contamination of products
- Mechanization enables a farmer use new and improved farming technology which is time saving
- Machinery make the operations done in a timely manner without relying on manual labour
- Farm mechanization is cheaper and efficient on a large farm scale thus a farmer is able to attain maximum profits from the farm produce obtained
- It ensures that farm activities are carried out effectively
- It reduces drudgery making work easy and enjoyable
- Farmers benefit from economies of scale of large scale production
- Crop quality is increased especially during harvesting and processing
- Compensates for labour peak periods

Limitations of farm mechanization

- It requires trained operators
- It is costly to small scale farmers to purchase, maintain and operating in case of need for fuel and electricity
- It leads to unemployment in areas where human labour is abundant and cheap as in the plantation
- Highly skilled operators require higher wages
- It leads to environmental pollution
- It may lead to deforestation and hence soil erosion

Safety measures when using farm machinery

- Do not leave machines running unattended
- Keep hands safe during cutting procedures
- Do not try to free a stalled blade before turning the power off
- Wear appropriate clothing for the work, e.g., overalls, masks and gumboots
- Farm chemicals should be handled, stored, used and disposed of as recommended to avoid poisoning or pollution of the environment
- Farm implements and machines should be used only after the instructions have been read and understood
- Blades which require sharpening must always be kept sharp
- Care should be taken when using electrical equipment to prevent electrical accidents and fires
- Farm workers should be trained in skills of lifting equipment to prevent back injuries
- All machines should be kept safely, and the entries to the buildings and other structures should be clear of tools, equipment and other pieces of waste which might cause accidents
- A fire extinguisher should be kept in an accessible place and should be operational
- Do not smoke, eat and drink while spraying
  - ✓ Washing hands well after spraying and before eating

TOPIC 5: FARM POWER

Farm power refers to the energy that is used to carry out different farm activities or operations

Sources of farm power

1. **Human power**

Fig.5.1: *People picking tea*

- Energy that is released by humans or people
- It may be referred to as labour
- It is a widely source of energy on the farm
- It is useful as it can be used anywhere and at any time on the farm
- It can be in terms of
  i. managerial ability
  ii. thinking ability
- It controls other sources of power

Categories of human power

a. Family labour

- It is provided by family members
- It is the most readily available source of labour in subsistence farming in most societies

Factors affecting efficiency of family power

i. Technical-know-how
ii. The number or size of the family and their respective ages
   - Determine quality and amount of work done

iii. The attitude and determination of the members to carry out the desired tasks

b. Hired labour

- It is labour in form of contracts in terms of
  - casual workers
  - permanent employees
- It is mostly used in commercial farms

Advantages of human power

- It is easy to manipulate since the number of people working on a farm can be reduced or increased depending on the amount of work available at a particular time
- It can be used to manage and control other sources of power, e.g., animal power requires the input of human power
- It can be from the farmer himself/herself and hence the farmer can determine the direction of operation as need arise
- It is readily available and cheap

Limitations of human power

- It is not easy to estimate accurately the amount of output produced by each person, especially when there are many people working on a farm
- The availability of human power at the time of need sometimes may not be guaranteed, e.g., a farm worker may fail to turn up for work with prior notice or they may fall sick
- It is slow and tedious
- There is a high limit to the amount and type of work that human power can accomplish with efficiency
- The amount of work done depends on the health, attitude and physical ability of the workers
  - It is dynamic

Ways of improving output from human power

- Provide the people offering the labour services with efficient tools for working
- Train and educate workers on various agricultural practices that will help to increase productivity on a farm, and how handle various machines and implements on the farm
- Motivate the human power by providing good working conditions and increasing wages often
- Supervise the labour for proper direction by recording the attendance and managing behavior or conduct of workers
- Let each farm worker know what is expected of him/her in the work place
  - Age, qualification and gender issues when assigning duties may be considered

- The work place should facilitate work output and ensure good health
- Give equal pay for equal work to ensure fairness
- Provide facilities for leisure, exercise and health where workers are housed nearby
- Proper feeding

2. Animal power

- This is energy released by draught animals
- Examples of draught animals include:
  - ✓ Horse
  - ✓ Donkey
  - ✓ Oxen
  - ✓ Mules
  - ✓ Camels
- Animals used for farm power in Malawi are
  - ✓ Oxen
  - ✓ Donkeys
  - ✓ Horses

The ox

- This is the most widely use animal as a source of farm power
- Oxen are used to operate ox-drawn implements, e.g., ploughs, ridgers, ox-carts

Advantages of the ox as a source of farm power

- It is generally hardy, strong and easy to feed
- It is easy to buy
- It requires little skills to operate ox-drawn implements
- It may be sold for meat after fattening at the end of the working life

Limitations of using ox as a source of farm power

- Some oxen may not be friendly hence may cause danger to the operator or the public
- Oxen require adequate grazing land which may not be available due to population pressure
- It is difficult to train the ox for farm work
- It requires human power to operate efficiently and they may not be available
- The speed of work of oxen is very slow
- Prevalence of diseases and parasites affects the health of the animals especially when there is an outbreak
- The ox works well on light soils and does not work efficiently on heavy soils, for cultivation purposes

The donkey

- It tends to be friendlier once trained for the work, hardy and generally meek
- It is mostly used for transportation purposes or carrying loads around the farm
- It can also be used for ploughing if a farm does not have oxen

Advantages of using a donkey

- It is cheaper to buy and rear than other farm animals
- It is easy to train and it responds fast to commands
- It is patient when given the right amount of work

Limitation of using donkeys

- It cannot carry very heavy loads and works for a few hours
- It works much slowly and gets tired if overworked or driven too fast
- It is susceptible to trypanosomiasis and hence requires protection from tsetse flies
- Constant whipping of a donkey easily leads to sores and wounds which may be a habitat for parasites thus may lead to death of the donkey

The horse

- Horses provide transport services to a farm
- A carriage is fixed on their backs and controlled by the farmer to determine the speed of their movement
- It is mostly used by large scale farmers, hence not very commonly used in Malawi

Advantages of sing horses as a source of farm power

- It is a friendly animal which develops attachment to the owners
- It does the job much faster than other farm animals
- It easy to handle, docile and can be controlled easily and accurately

- The horse can be trained to perform various tasks on the farm

Limitations of using a horse

- Under the tropical conditions, the horse does not reach the maximum required growth weight
- It has generally weak body conformation; hence it requires proper care and attention
- It is more susceptible to trypanosomiasis
- The horse cannot work for long hours continuously as it gets tired quickly
- It is generally expensive to buy a horse and rear it, hence its availability on the farms is quite limited

General advantages of animal power

- More heavy work can be done by animals than humans
- Animal power is generally cheaper than machinery power, e.g., tractor generated power
- Animals can work conveniently on narrow pieces of land
- It does not require specialized skills as is in the case with mechanical power where specialized training and license or permits to operate the machine are required
- Animals provide valuable dung for biogas and farmyard manure

Limitations of animal power

- There is need for adequate grazing land, which is limited in some places due to population pressure
- Animals are prone to diseases and parasites attack that either kill the animal if not treated or reduce ability to perform
- Animal power requires suitable weather conditions, e.g., under high temperatures, the animal power output will be severely reduced
- Animals require time for grazing and resting; hence do less work than engine power

Ways of improving the output of animal power

- Treat and handle the animals humanely; do not cause injuries to the animals or overload them
- The working environment must be suitable and without obstacles or objects which might hinder efficiency of work produced or injure the animal
- Avoid using the can or whip to push the animals to work; use verbal instructions or visual gestures because animals are keen learners
- The animals should be well fed and in good health for efficient power output
- Match the animals equally when working
- The working equipment must ensure that safety of animal
- Handle the animal gently and allow enough rest period after work before feeding them
- Pay attention to the hooves of the animal
  - Long hooves often lead to injuries, hinder fast movements and predisposing factor for foot-rot
- The animals should be provided with proper housing to protect them from harsh weather conditions and attack by predators or from being stolen

3. Wind power

- It is power that is converted and used in wind turbines to produce electrical power
- It is mostly used to pump water using wind pumps
- Windmills provide mechanical power

Advantages of wind power

- It is plentiful
- It is renewable

It produces no greenhouse gas

- Power is generated at a very low cost
- It is generally easy and cheap to maintain
- It is a clean source of power that can be relied on even in future as it does not cause environmental pollution or global warming

Limitations of wind power

- The initial cost is relatively high depending on the size of the windmill or wind turbines to be used
- The working of the windmill is controlled by the motion of the wind to which the farmer does not have control
- It is unreliable since it depends on wind velocity
- Low short-term predictability

- Can drop from maximum output to zero output in no time

Ways of improving output from wind power

- The wind turbines should be placed vertically to improve the output power
- The turbines should be placed close together to ensure maximum utilization of the wind
- When constructing windmill, high towers should be constructed so that a high amount of wind is utilized to increase wind power output
- Having bigger blades

4. Mechanical power

- This is the power generated by machines
- The machines are driven by
  - ✓ Wind power
  - ✓ Water power
  - ✓ Biogas
  - ✓ Fossil fuels
  - ✓ electricity
- Mostly used in commercial farms

Advantages of mechanical power

- It has led to an increase in agricultural production
- It has led to rural development
- It has encouraged farmers to start practicing agriculture on a large scale
- It is efficient and effective

Disadvantages of using mechanical power

- It leads to unemployment of people, especially those who are unskilled
- It leads to environmental pollution
- Heavy machinery destroy soil structure leading to soil degradation
- It has led to a rise in deforestation due to creation of estates 9large farms)

Ways of improving mechanical power output

- Educate and train operators of machines on how to handle and use the machines effectively so that damage is not caused during use
- Practise frequent maintenance of the machines to ensure that they last longer and that they perform effectively
- Use each machinery according to the purpose or function that it is meant for or to perform

5. Water/hydro-power

- This is energy that is converted and used in water turbines to produce electrical power
- Hydro-electric power can be used to drive grinding mills or other machines and to produce electricity

Factors affecting water power

- The volume of water flowing per minute
- The height or vertical distance at which the water drops from the point where the power installation is located

Advantages of water power

- Water is used but it does not reduce in quantity
- It is produced all the time as long as the source or body of water does not go dry
- There is no waste products during the production of electricity

Limitations of water power

- A power plant is very expensive to construct
- The source of power is dependent on water and thus cannot produce power when the levels of water are very low
- The water used in generating power is also used for domestic and industrial purposes making the levels of water to go down significantly to limited amount of power produced

Ways of improving water power

- Replace old turbines with new ones to increase power output
- Shut the outlets of the dam to prevent water flow so as to preserve the water for use when the demand for water power is high

6. Solar power

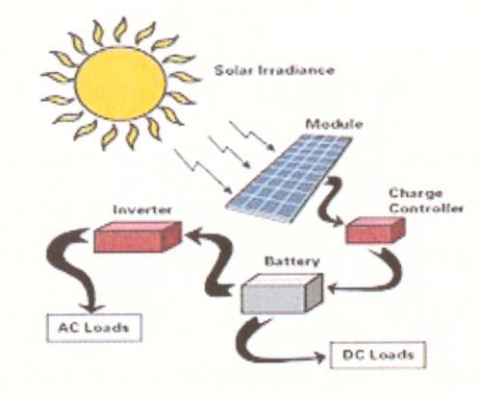


Fig.5.2

- This is the energy from the sun
- It is ideal for heating and drying of agricultural produce as well as lighting
- It is also used for photosynthesis
- As a source of power, solar energy is trapped from the sun's rays using solar panels and stored in solar batteries

Advantages of solar power

- It is cheap and easy to install
- It can be used to supply electricity to homes and drive electricity electrical machines like water power
- It is environmentally friendly
- It is inexhaustible because it does not get consumed in the process of use
- It is readily available

Limitations of solar power

- It depends on the sunshine's intensity and its duration, over which human being has no control
- The storage equipment for solar power tends to be generally expensive
- It requires qualified technical-know-how for maintenance and this may not be easily available in the rural areas.

Ways of improving solar power

- Buy durable and effective solar panels that will be used in absorbing more energy from the sun
- Installation of the panels should be done appropriately
- Solar concentrators should be used to concentrate the energy from the sun to the solar panels
- The solar panels should be placed in open areas where there is no shade so that the maximum amount of energy from the sun reaches them
- Avoid accumulation of dust on the panels

7. Wood energy

- It is farm power obtained from firewood, charcoal and other by-products of timber
- Heat from wood energy is used for
  - ✓ Boiling water, cooking or heating
  - ✓ Drying crops
  - ✓ Curing Dark Fired Western tobacco and flue-cured tobacco

Advantages of wood energy

- It is cheap
- It is renewable and sustainable since each tree that is cut can be replaced
- It is carbon-neutral since it does not release CO_2 in the atmosphere nor greenhouse effect
  - ✓ CO_2 released into the atmosphere exactly equals CO_2 that was absorbed by the growing trees)
- It is locally available and abundant(security of supply) for rural communities that are on the ESCOM grid
- It is easier to store than other forms of power
- It is easy and quick to use

Limitations of wood energy

- It is not very clean
- It has less energy density(less energy per kilogram) than other sources (coal)
- It produces high level of indoor air pollution from smoke, soot and other harmful gases that can cause acute respiratory infections, cataracts and death
- It is the main cause of deforestation in Malawi and threatens the ecosystem and biodiversity
- It is inconvenient because stoves and boilers require refilling every few hours
- It takes a long time to grow a large amount
- It is hard to harvest, gather and process
- It is bulky, cumbersome and uneconomic to transport

Ways of improving output from wood energy

- Use more efficient wood-burning stoves and boilers
  - ✓ to provide more complete combustion
  - ✓ to reduce air pollution in the household

- Drying, grinding and pressing biomass into wood pellets, e.g., sawdust, wood shaving increases the density of wood

8. Biogas power

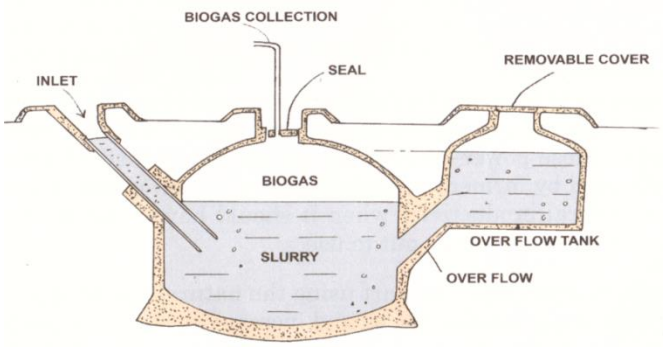


Fig.5.3

- It consists of a mixture of gases
- These gases are produced when organic matter is broken down
- Normally, biogas does not contain oxygen

Biogas production on a farm

- ❖ Biogas can be derived from livestock dung and droppings
- ❖ The dung and droppings decompose in the digester through biochemical reactions.
- ❖ In the digester, the dung and droppings are mixed with water in form of slurry
- ❖ The decomposing organic matter changes into carbohydrates, sugars, and volatile and eventually to biogas.

Components of biogas equipment

- ✓ Digester tank
- ✓ Gas collector assembly
- ✓ Inlet and outlet pipes

Advantages of biogas

- It is the cheapest source of power to run after the initial cost
- Maintenance requirements are simple and include mainly cleaning
- The by-products of fermentation provide high quality manure
- It is environmentally friendly

Limitations of biogas

- The initial cost of installation may be prohibiting to some farmers
- It requires constant supply of organic materials including cow dung
  - ➢ Maintenance of animals is an essential requirement for biogas production

Ways of improving biogas output

- Use of other waste products, e.g., sewage and industrial wastes should also be made to avoid overdependence on animal waste only
- Installation of a larger digester which can accommodate large amounts of dung supplied
- Refilling the digester regularly so that there is always enough dung in the digester

TOPIC 6: GENDER AND AGRICULTURAL TECHNOLOGY

- ❖ Gender refers to the condition of being male or female and its associated roles as assigned by one's society and culture
- ❖ Gender bias refers to unequal or unfair treatment or favouritism between male and females due to prejudice
- ❖ Gender equality is the fair treatment between males and females

Benefits of gender equality in agricultural technology

- Reduction of rural poverty
- Improved food security
- Improved health and nutrition
- Sustainable management of natural resources

Situations that show gender bias in agricultural technology

- There are very few friendly farm tools and equipment for women to use and handle working on the farm
  - ➢ Each technology is designed for a specific type of gender
  - ➢ Many tools are too heavy or require a lot of effort for women to be able to operate them
- Women are given hand tools to perform various tasks whereas the complex machines and technology are left to the men
- Heavy machinery and equipment which are mostly used in large scale farming are only operated by men

- Limited access to finance for women involved in agricultural production
    - ➢ This makes them unable to acquire most agricultural resources
- Seminars and technical courses that are organized to provide education and training on how to use various agricultural technologies are sometimes organized in distant areas where women may not be able to go
    - ➢ Due to other chores around the home
- Most agricultural extension workers are males; and they make more contacts with male farmers than female farmers

Causes of gender biases in agricultural technology

(a) Culture
(b) Gender role socialization
(c) The farmer's internal belief system
(d) Lack of early exposure to technology among females
(e) Lack of confidence among females in the use of agricultural technology
(f) Low level of education and literacy among women
(g) Lack of technological information among females
(h) Limited access to capital by females
(i) Gender stereotypes against women's ability
(j) Gender expectations

Effects of gender bias in agricultural technology

(a) Limiting the full range of person's (women's) capabilities

(b) Low contribution from one gender to agricultural production
(c) Low agricultural productivity
(d) Low farm income
(e) Poverty
(f) Food insecurity and starvation
(g) Slow agricultural development

Ways of dealing with gender bias in agricultural technology

- Giving females opportunities to prove themselves and develop self-confidence
- Discrediting gender stereotypes
- Promoting equal education and skills development
- Reducing women's work burden
- Improving women's access to farm capital
- Empowering women in the use of agricultural technology
- Developing documentaries for the print and media on successful women farmers, to serve as role models to would-be upcoming women farmers
- Reviewing land and property ownership

TOPIC 7: IMPROVED FARMING TECHNOLOGY

- ❖ **Technology** is an art or skill
    - ➢ It involves
        - ✓ Making tools and machines
        - ✓ Modification of tools and machines
        - ✓ Use of tools and machines
        - ✓ Knowledge of tools and machines
- ❖ **Technology** also refers to methods organizing activities and ideas to solve a problem or improved the old approaches of solving problems

Classification of technology in farming

a) Unimproved farming technology

- This is the use of old techniques, equipment and tools in agricultural production

Examples of unimproved farming technology

- ✓ Shifting cultivation
- ✓ Open-range grazing
- ✓ Monocropping
- ✓ Monoculture
- ✓ Use of local crop varieties and breeds of livestock
- ✓ Use of local and simple handle tools

Consequences of using unimproved farming technology

- It leads to a lot of time being spent to accomplish various farming tasks resulting into shortage in food supply due to low yield
- Some of these technologies lead to destruction of vegetative cover, desertification and soil erosion
- Monocropping and monoculture lead to the spread of diseases and pests in crops due to their build-up in the soil

b) Improved farming technology

- This refers to the use of new and better machinery or equipment to improve livestock and crop production
    - ➢ It involves application of scientific knowledge in agricultural production

Examples of improved farming technology

- ✓ Breeding technology
- ✓ Crop and livestock protection technology
- ✓ Herbicide technology
- ✓ Fertilizer technology
- ✓ Mechanization
- ✓ Irrigation technology
- ✓ Soil conservation technology
- ✓ Soil drainage technology
- ✓ Temperature modification technology
- ✓ Mobile technology
- ✓ Computer technology
- ✓ Stock feed manufacturing technology

Improved farming technology and food supply

Indicators of improved farming

- New discoveries and advances in the quality of machinery, tools and new technology equipment to improve the performance level and efficiency of the farm
  - ➢ The correct use of these technologies leads to an increase in crop and livestock production which causes an increase in food supply
- Advances in dairy farming which include animal breeding or rearing practices
  - ➢ They lead to an increase in livestock production hence ensuring a constant supply of livestock products and by-product used as food
- There is a suitable supply of food which is created through the use of improved technology when practicing horticulture
  - ➢ The production of fruits and vegetables in controlled environments increases their supply
- Irrigation systems have been used to provide water to crops in arid and semi-arid areas
  - ➢ This has led to the reclamation of land for agricultural use resulting into growing of more crops under irrigation thereby increasing food supply for the rapid population

Improved farming technology and food security

(i) Increasing productivity and yield
(ii) Improved nutritional content of foods
(iii) Reducing post-harvest losses
(iv) Processing food
(v) Reducing food wastage at point of consumption
(vi) Distributing food efficiently
(vii) Increasing profits

TOPIC 8: AGRICULTURAL MARKETING AND TRADING

a) Marketing refers to all the processes involved in the transformation and flow of products and services from the point of production to consumption.

Four elements of marketing (the 4Ps of marketing)

1) Identification, selection and development of a ***product***.
2) Determination of its ***price***.
3) Selection and distribution of the product to reach the customer ***place***.
4) Development of a ***promotional*** strategy.

b) Trading refers to the process of buying and selling of goods and services or exchange of commodities.

Difference between marketing and trading

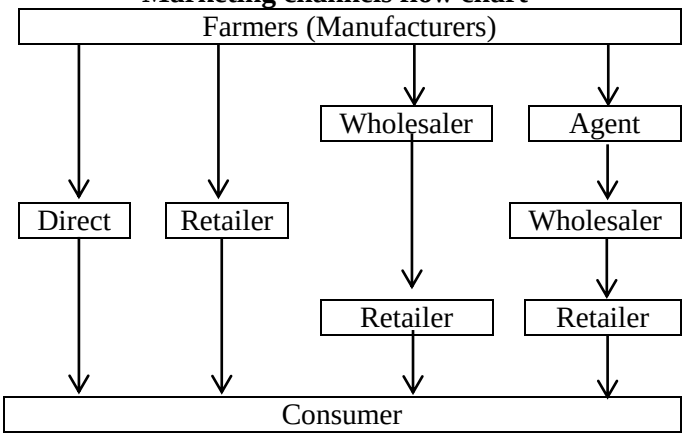
Marketing	**Trading**
Concerned mainly with the satisfaction of the consumer	Concerned mainly with the local sales
Involves numerous processes hence very wide	Involves only buying and selling hence not wide
Produces after through research to determine what the consumer wants	Uses resources to buy and then sell at a profit
Produces to the market demand and make some profit	Aims at making profit by disposing any surplus commodity
Uses selling as means of communicating with consumers and understanding their needs	Uses selling as a means to an end
Directs resources of the farm to produce the commodities consumers need	Directs sources to bring about a sale/purchase

Makes attempt to adapt to changes in consumer characteristics or need (i.e. changes in consumer tastes, lead to changes in the commodity, to satisfy consumers)	Makes attempts to develop a stronger sales drive (i.e., changes in consumer tastes may lead to changes in sales strategy)

Marketing channels and agencies

- ❖ Marketing channels refer to the means or ways through which agricultural products are made available to the customers
  - ➢ This is in case the products are not sold directly

Marketing channels flow chart



Channel of Distribution 1 (Manufacturer to Consumer)

- The agricultural products are sold directly to the consumer without any intermediaries, e.g., wholesaler or retailer
- This is usually done by small scale farmers

Channel of Distribution 2 (Manufacturer to Retailer to Consumer)

- This involves the sale of agricultural goods or products from the farmer to retailers
- The retailer then avails the products to consumer
- It is used in:
  - i) Sale of processed agricultural products
  - ii) Selling agricultural products that have been produced on a large scale, e.g., maize

Channel of Distribution 3 (Manufacturer to Wholesaler to Retailer to Consumer)

- The farmer sells his or her agricultural products to a wholesaler who in turn sells them to a retailer
- The retailer eventually sells the products to the consumer

Channel of Distribution 4 (Manufacturer to Agent to Wholesaler to Retailer to Consumer)

- The agent is usually used to sell the products to wholesalers
- The agent is usually given a commission by the farmer (manufacturer)
- This makes the products to reach the consumers faster
- The agents distribute the goods to the wholesalers who then sell them to the retailers and finally the retailers sell to the consumers

Marketing agencies

Marketing agencies are referred to as bodies or organizations which are involved in one or more marketing functions.

Common examples of marketing agencies

a) Itinerant traders

- These are middlemen who move from place to place buying agricultural produce of various types from farmers, e.g., cattle, goats, grains and vegetables
- They sell their commodities to large businesses in big towns
- They perform the functions of:
  - (i) Buying
  - (ii) Assembling
  - (iii) Selling

b) Processors

- These are marketing boards that undertake changing or transforming raw products into finished products, which are more usable forms, e.g., flour, juices, tea, sugar, butter

c) Wholesalers

- These buy in bulk from processors or manufacturers and sell to small traders (retailers) who later sell in small quantities
- They repackage goods into smaller units that are desirable to the consumer

d) Retailers

- They buy in bulk from the wholesalers and sell to consumers in small bits

e) Brokers and agents

- These are middlemen who act on behalf of others and are paid a commission fee
- They link up the buyers to sellers and sellers to buyers

f) Cooperative societies and unions

- This arrangement makes marketing of agricultural produce or products easy, starting from villages to national or international market

g) Marketing boards

- They are formed by the Ministry of Agriculture
- They provide means by which the government participates in marketing
- The board tries to stabilize the producer (farmer) income by means of orderly market control
- They help to increase producer incomes by overall production restriction programme, e.g., production quotas

Roles of marketing channels and agencies

- They ensure that the market prices of goods are kept stable so that they do not keep on fluctuating
- They promote and advertise agricultural goods or products in specific areas
- ➢ They come up with the sales incentives that are used to attract customers, e.g., promotions

- They link the producer to the consumers
- They distribute and make agricultural goods available to consumers
- They provide market to the farmers' produce
- They provide the farmer with information and inputs at farmer subsidized prices
- They provide information on the needs and demands of the consumers to the manufacturers

Marketing costs and margins
Marketing costs

Marketing costs refer to the total costs associated with delivering agricultural commodities from the farmer to the consumer

Calculating the marketing cost

Consider the following:

1. Jams sold 300 bags of mangoes. He used MK1000 to transport the mangoes to the market. Initially, he had spent MK400 per day in storing the mangoes in a warehouse pending delivery for 2 days. Calculate his marketing cost.

Solution

Marketing cost = MK1000 + MK400 + MK400

= MK1800.

2. Table below shows the total marketing cost for a maize bag

Marketing channel level	Charges (MK)	Price (MK)	%share
Farmer level • Farm-gate price (Chitipa)		9000	25.00
Itinerant trader (Chitipa) • Cost of a hessian sack • Transport cost to Mzuzu • Itinerant trader's returns	 150 2850 6000 9000	18000	25.00
Wholesaler level (Chitipa) • Grading • Packaging • Storage • Wholesaler's returns	 1000 1500 1000 2500 6000	24000	16.67
Retailer level (Mapale) • Transport to Mapale • Displaying and advertising • Storage • Retailer's returns	 300 2400 1300 8000 12000	36000	33.33
price@finalconsumer	-	36000	-

Calculate the marketing cost for the bag of maize.

Solution

Marketing cost

= (150 + 2850) +(1000 +1500 + 1000) +(300 + 2400 + 1300)
= MK3000 + MK3500 + MK4000
= MK10500

Marketing margins

- Marketing margins refer to the difference between the cost of purchasing items and the income made from selling them
- It is used to calculate the profits being made
  - A high marketing margin shows that the level of profitability is high whereas low marketing margins show that level of profitability is low

Marketing margin

= Cost of selling items – Cost of purchasing items (Farm-gate price)

Calculating marketing margins

Consider the following:

A farmer bought a litre of milk at MK40. He made cheese from the product and sold it at MK100. Calculate the marketing margin of the farmer.

Solution

Marketing margin

= Cost of selling item – Farm-gate Price
= MK100 – MK40
= MK60

∴The marketing margin of the farmer is MK60.

Or

Marketing margin

= Marketing costs + trader's returns

Relationship between marketing margins and costs

Marketing margins directly affects the marketing costs and channels. The higher the marketing margins show that there is need for more funding for the commodity to reach the market (consumer), hence higher marketing costs.

Effects of population distribution on marketing

- High population in an area creates a better market for agricultural produce and the vice versa
  - Most agricultural produce are food
- High population makes the marketing channel longer
  - It raises the prices of commodities
- High population leads to more advanced means of transport being used
  - It ensures commodities to reach the consumer at an appropriate time
- High population ensures sale of good quality products in an area
  - As a result of competition among traders
- High population brings about more advanced methods of advertising
  - In order to target different groups of consumers

Importance of trading in agricultural commodities at community level

- It provides outlet for excess produce from farm holdings in the community
- Promote efficient division of labour within the community
- Promotes specialization
- Improves living standards of the community members
- It enables those who do not get adequate food from their farms to buy from those who have surplus
  - This is possible through community markets
- People get self-employed
  - Through buying and selling agricultural commodities
- It is a source of revenue for local authority
  - Through market fee
- It provides food security within the community
  - Traders within the community buy, store and sell agricultural commodities in terms of scarcity
- Ensures flow of cash in the community
  - People from outside the community bring more cash into the community when they buy the agricultural commodities

Importance of agricultural trading at national level

- It ensures steady supply of various agricultural commodities
- The government and traders earn revenue
- It promotes agricultural allied industries, e.g., agro-chemicals manufacturers, farm tools and equipment dealers and processors

- Trading provides employment to those in the trading system
- It provides market for the farmer produce from various parts of the country
  - Through national marketing boards
- Primary cooperative societies can also sell their produce to national cooperative societies
  - Thereby providing a good market link from local to national level
- Trading ensures food security in a country
  - Through national marketing boards that buy, store and sell the commodities in times of scarcity
- Marketing boards provide storage facilities for food

International trading

- International trading is carried outside boundaries of a country

Classes of international trade

(a) Bilateral trade
- This is trade between two countries

(b) Multilateral trade
- This is trade among many countries

Features of international trade

- ✓ Two or more countries are involved
- ✓ Involves people of different culture
- ✓ Countries involved usually have different monetary units

Importance of trading in agricultural commodities at international level

- A country is able to get agricultural commodities that it does not produce
- The country is able to export her surplus produce
- It widens the market for the country's agricultural commodities
- It increases the living standards of the citizens of the country
- It encourages specialization in particular agricultural commodities
- It enables the country to earn foreign exchange
- It ensures importation of food to meet the country's deficit
- It establishes good relationship among countries involved in trade
  - The country can get international aid for development
  - Peace is established with neighbours

Problems associated with international trade

- It hampers infant industries due unfair competition from cheap imports
- Some harmful or unsuitable commodities may be imported , e.g., weeds, diseases, crop varieties
- In case of instability between two countries, members of the two countries may suffer
- It may lead to unfavourable balance of trade, where developing countries export less than what they import
- There may be political patronage due over-relying on rich partners of trade
- Members of the country may acquire bad cultural values from trading partners

Factors that facilitate trade of agricultural commodities

(i) Commodities produced in one area are needed for use in another area
(ii) Consumers usually choose what to buy
(iii) Commodities produced in one area may not be produced in another area
(iv) Commodities produced in different areas may not be similar but significantly differ in their quality
(v) Harmonize taxation
  - This ensures that traders are not overtaxed

Ways of improving trading of agricultural commodities

- Formation of produce cooperative societies from local to national level
- Value addition
  - Processing the commodities rather than selling them raw
- Provision of appropriate storage facilities
  - Commodities can stay fresh or with good quality for longer periods
- Good roads
  - Upgrading roads that seem to be impassable during wet season
- Farmers should be given subsidies on agricultural inputs
  - To increase levels of production
- Making capital available to traders of agricultural commodities
  - Through giving loans with easy term repayment, low interest rate, low rates of payment and less collateral or security

TOPIC 9: PRICE ELASTICITY OF DEMAND AND SUPPLY

- Quantity demanded refers to a specific amount of a product that will be brought at a specific price over a specific period of time
- Quantity supplied refers to the amount of commodity that has reached the market for sell

Price elasticity/sensitivity of demand

- Elasticity of demand refers to the degree of responsiveness of quantity demanded of product to a percentage change in price

Calculating price elasticity of demand (E_d)

$$E_d = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price}}$$

Percentage change in quantity demanded

$$= \frac{\text{Change in demand x 100}}{\text{Original demand}}$$

$$\text{Percentage change in price} = \frac{\text{Change in price x 100}}{\text{Original price}}$$

Consider the following:

Banda sell a bag of maize at MK4000. He normally sells 700 bags every month. In the month of January, he decided to charge more money per bag. He raised the price to MK5000 per bag. However, he managed to sell 400 bags. What is the price elasticity of demand?

Solution

$$E_d = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price}}$$

Percentage change in quantity demanded

$$= \frac{\text{Change in demand x 100}}{\text{Original demand}}$$

$$= \frac{(700-400)100}{700}$$

$$= \frac{300 \text{ x } 100}{700}$$

= 42.86 %

- The quantity demanded reduced by 42.86%

$$\text{Percentage change in price} = \frac{\text{Change in price x 100}}{\text{Original price}}$$

$$= \frac{(5000-4000)100}{4000}$$

$$= \frac{1000 \text{ x } 100}{4000}$$

= 25%

- The price increased by 25%

$$\text{Therefore, } E_d = \frac{42.86\%}{25\%}$$

= 1.7

Degrees of price elasticity of demand

1. ***Elastic demand***
   - This is when a change in price leads to a significant change in demand
   - The price elasticity o demand is greater than 1 ($E_d > 1$).
   - The implication of elastic demand is that products have to be sold at competitive prices for one to gain an edge

2. ***Unitary demand***
   - This is when a percentage change in the price of a commodity will result in an equal percentage change in the quantity demanded but in the opposite direction
   - Price elasticity of demand is equal to 1 ($E_d = 1$)
   - The implication of a unitary demand is that buyers can always get alternative products if the prices of an inferior product rises
   - It usually leads to great competition

3. ***Inelastic demand***
   - This is when the quantity demanded of a product is **NOT** or is only **SLIGHTLY** affected by the change in price
   - The implication is that the price of the commodity may be raised
   - The profit when selling such a product is high

- The price elasticity of demand is less than 1 ($E_d < 1$).

Implications on price elasticity of demand

- Reducing risk and uncertainty
  - Guides farmers to make right decision and take right actions without endangering demand for the commodity
- Sales forecasting
  - The farmer forecast the impact of a change in price on its sales volume and total revenue
- Influencing pricing policy
  - The farmer decides when to raise or lower the price
  - The farmers decides whether to price discriminate
    - ***Price discrimination*** is a policy of charging different consumers different prices for the same product
- Influencing non-pricing policy
  - In case of highly elastic, the farm can use advertising and other promotional techniques to reduce elasticity

Price elasticity of supply

- Price elasticity of supply is the degree of responsiveness of quantity supplied of a given product due to a change in the price of the product

Calculating price elasticity of supply (E_s)

$$E_s = \frac{\text{Percentage change in quantity supplied}}{\text{Percentage change in price}}$$

Percentage change in quantity supplied

$$= \frac{\text{Change in quantity supplied x 100}}{\text{Original quantity supplied}}$$

Consider the following:

Calculate the elasticity of supply of beans when 1000 bags of beans were supplied in a market by Mary at a price of MK3000 per bag. She later on supplied 2500 more bags to the same market when the price changed to MK4000 per bag.

Solution

$$E_s = \frac{\text{Percentage change in quantity supplied}}{\text{Percentage change in price}}$$

Percentage change in quantity supplied

$$= \frac{\text{Change in quantity supplied x 100}}{\text{Original quantity supplied}}$$

$$= \frac{(2500-1000)100}{1000}$$

$$= \frac{1500 \text{ x } 100}{1000}$$

= 150 %

- The quantity supplied increased by 150%

Percentage change in price $= \frac{\text{Change in price x 100}}{\text{Original price}}$

$$= \frac{(4000-3000)100}{3000}$$

$$= \frac{1000 \text{ x } 100}{3000}$$

= 33.3%

- The price increased by 33.3%

Therefore, $E_d = \frac{150\%}{33.3\%}$

= 4.5

Degrees of price elasticity of supply

1. ***Elastic supply***
   - This is when the change in price results in a great change in the quantity of the commodity being supplied
   - The elasticity of supply is greater than 1 ($E_s > 1$)

2. ***Unitary supply***
   - A change in price causes an equal or proportional change in the quantity supplied of a commodity
   - Price elasticity of supply is equal to 1 ($E_s = 1$)

3. ***Inelastic supply***
   - A change in price of a commodity results in **NO** change or a **very small** change in quantity supplied
   - The price elasticity of supply is less than 1 ($E_s < 1$)

Implications of elasticity of demand and supply

- A slight reduction in prices of commodities will increase the demand and consequently lead to an increase in supply for unitary commodities

- The inelastic commodities will be bought regardless of the price
- Elastic commodities are always stored until the demand is high so that farmers do not sell them at a low price and incur losses
- Government subsidies on agricultural inputs lead to low prices of elastic and unitary commodities leading to high competition at the market
- Increase in the price of a commodity with elastic demand lead to an increase in demand of the alternative commodity thereby causing producers to increase supply of that alternative commodity.

TOPIC 10: CROP IMPROVEMENT

❖ Crop improvement refers to the genetic alteration or modification of plants to produce high crop yields in order to satisfy the needs of humanity

Aims of crop improvement

1. Increasing the yields of the crops
   - High yielding crop varieties are used when coming up with improved crops
2. Growing quality crops which are much healthier
   - Healthy crops produced have a high nutritional value
3. Ensuring that the crops produced are pest and disease resistant or tolerant
   - Such crops can also survive harsh weather conditions which are brought about by climate change
4. Production of crops with good qualities for storage
   - Ensures a constant food supply thus food security in the country and in the world
5. Processing the qualities of superior crops to ensure continuous production of crops that are of high quality

NOTE:

- The first and the second are the main aims of crop improvement
- Two main components of yield quantity of crop improvement are:

  (a) Biomass: the capacity to produce adequate quantity of vegetable material

  (b) Partition: the capacity to divert biomass to the desired product

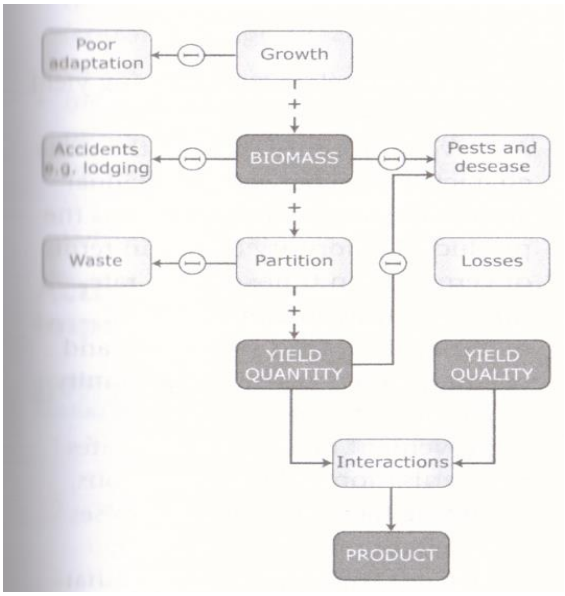


Fig.10.1

Activities involved in crop improvement

- Most of the activities involve ***breeding***
- ***Breeding*** is the process of changing specific plant traits (characteristics) in order to obtain desirable characteristics in crops
- Breeding is done through
  i. Self-pollination
  ii. Cross pollination

Steps or activities for plant breeding

- Identifying plant characteristics that are needed, desirable and can increase the economic value of the crop
- Identifying sources of germplasm (superior parents) for the characters being sought.

Places where germplasm can be collected

- ✓ Farmer's fields
- ✓ Seed companies
- ✓ Gene sanctuaries
- ✓ Centres of diversity
- ✓ Gene banks

Examples of organizations that manage gene banks

- International Crops Research Institute for Semi-Arid Tropics (ICRISAT)
- International Institute of Tropics Agriculture (IITA)
- Centre International de Mejaromients de Maize (CIMMYT)

- Choosing plants that have the desirable characteristics
- Evaluating (judging) parental crops
- Developing breeding lines
- Manipulating the useful agronomic characters to produce improved cultivars using appropriate methods of crop improvement
- Registering the variety where the breeder is required to pay a fee, offer of acceptance name and provide the necessary batch of seed for field trials
- Conducting field evaluation of the cultivar to establish its legal identity (done by a responsible government authority)
  - ✓ Field testing is conducted based on
    - Distinctiveness: observing distinguishable characteristic from the already existing varieties
    - Uniformity: observe if the variety is sufficiently uniform to meet the requirements as expected from features of its propagation
    - Stability: observe if the essential characteristics remain unchanged after repeated propagation
- Certifying seed to protect the rights of the breeder
- Multiplying seed(done by breeder) while meeting the requirements of purity, quality and health
- Multiplying seed for release to farmers (commercial multiplication), usually done by seed companies

Rules in plant breeding

The breeder must observe rules regarding:

- Choice of land in relation to previous cropping
- Isolation from potential contamination
- Agronomic practices
- Cleanliness and suitability of equipment and stores
- Labeling methods and packing

Methods of crop improvement

1. **Introduction**
   - Introduction refers to a process where a certain crop variety is brought to a new area
   - The crop is grown under specific climate conditions from those it was well adapted to, e.g., tobacco was introduced in Malawi

2. **Selection**

❖ Selection involves identification of plants or crops with desirable qualities and then breeding is done

Methods of selection

a) Mass selection
- Seeds from various crops with desirable qualities are selected
- The seeds from the selected crops are mixed and planted to come up with the next generation of crops
- Alternatively, the best crops can be chosen and harvested separately
- Their progeny can then be grown
- Their seeds are harvested and preserved for future crops
  - Selection of naturally occurring plant varieties is the simplest and least expensive method of crop improvement

b) Pure-line/single plant selection
- Crops that appear to have desirable qualities from a healthy population are selected
- Progenies from the selected crops are then planted and observed frequently over a period of years
- The best progenies that have the most superior qualities are chosen as pure-line breeds
  - Seeds from pure-line breeds are usually similar in appearance and performance

3. **Genetic engineering**

- This is a method which involves human intervention in a laboratory setting directly manipulating the DNA of the plant
- Genetic engineers insert the desired foreign gene into the host DNA to produce the desired characteristics

4. **Hybridization/breeding**

❖ Hybridization is the combination of genes found in two or more crops to come up with pure breed progenies that are superior to the parent crop in all ways

❖ Plant breeding is the science of changing specific plant traits to come up with plants that have desirable characteristics
  - ➢ Seeds from hybrid varieties are then given to farmers

Steps necessary for successful hybridization

(a) Choosing parents
- Parental varieties must have superior characteristics that complement each other, e.g.,
  - ➢ A crop that is high yielding but susceptible to diseases to be crossed with a low-yielding crop that is disease resistant
  - ➢ A high yielder that is tall growing (lodges easily) to be crossed with a low yielding-dwarf
  - ➢ A late-maturing high yielder to be crossed with an early –maturing low yielder

(b) ***Self-pollinating the parental*** lines/Inbreeding
- The chosen parents are self-pollinated (or mated with close relatives) for several (5-6) generations
- It results in ***inbreeding depression***
- ***Inbreeding depression*** means reduction in plant vigour

(c) Cross the pure lines
- Pollen from one inbred (pure line) is collected and transferred manually to the stigma of the flower of the other inbred
- It results into ***hybrid vigour*** or ***heterosis***
- ***Heterosis*** refers to the new vigour which the crop acquires through cross-breeding

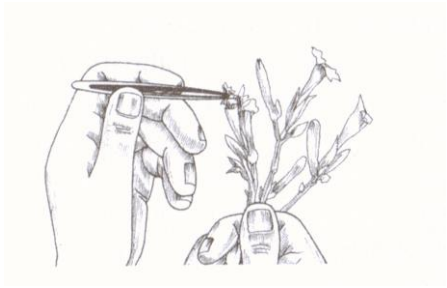


Fig.10.2a

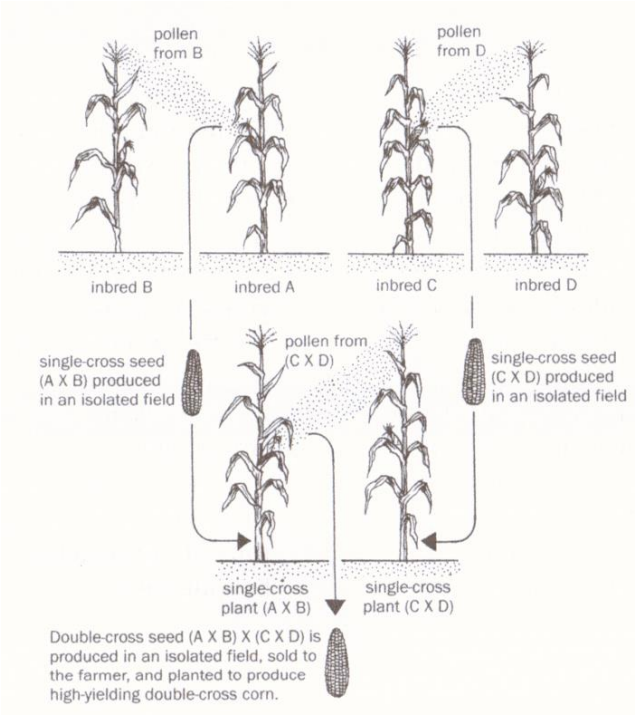


Fig.10.2b

Traits tended to be developed by breeders in various crops

- Increased quality and yields of crops
- Increased tolerant to environmental pressure
- Resistance to viruses, fungi and bacteria
- Increased tolerant to insect pests
- Increased tolerant to herbicides
- Adaptation to resist such mechanization as shattering when being harvested using machines

Crop processing

❖ Crop processing is the conservation of raw agricultural produce into products that are more valuable, usable and marketable
- It involves all post-harvesting activities that are carried out by farmers and cooperative societies

Importance of crop processing

- It improves shelf life of some of the agricultural products
  - ➢ Through addition of preservatives which make them to last long
- It improves the taste of the finished food products
  - ➢ Through additives and flavours
- It adds value to the produce
  - ➢ Processed products can be used for different purposes, e.g., wheat flour
- It makes the produce less bulky

- It reduces preparation time before consumption
- It provides a substitute for the fresh commodity during the off-season
- It increases variety of forms of the crop available to consumers
- It provides employment to people living in that particular area
  - Reducing the number of unemployed individual
- It improves the quality of the finished products
  - The product fetches more money compared to the raw crop
- It ensures that there is a constant supply of food leading to food security
  - Processed foods can be stored for long periods of time and used when there is food shortage in the markets

Processing mushrooms

Procedure

- **Washing:** Fresh mushrooms are washed in cold water
- **Blanching:** Then they are blanched in boiling water for about 4 minutes
- **Salting:** The mushrooms can be salted before drying and canning them
- **Drying:** The mushrooms can be dried through:
  (a) Sun drying
    - Mushrooms are spread in the sun
    - It is cheap
    - It takes a long period as it depends on weather conditions
    - There is high risk of deterioration during drying

  (b) Hot-air drying
    - Hot air circulation over the mushrooms promotes evaporation and drying of the product

  (c) Vaccum drying
    - Mushrooms are dried in a vacuum at low temperature
    - The product quality is superior to that from sun drying and air drying

  (d) Microwave drying
    - Mushrooms are dehydrated under controlled microwave conditions.
    - It results into a product of highest quality (better colour, texture and consistence).
- **Sterilization:** The mushrooms are sterilized by processing them in brine containing sodium chloride, with a small addition of citric acid.

TOPIC 11: PASTURE

- Pasture refers to land that is covered with grass and other herbaceous plants suitable for feeding livestock.

Importance of pasture

- Growing pasture reduces volumes of surface run-off by encouraging water infiltration into the soil
- Pasture provides livestock with food
  - Animals that feed on pasture:
    a) are less stressed
    b) are fertile
    c) live long
    d) provide human beings with good quality meat
- Planted pasture acts as a permanent cover crop
  - Protects the soil from agents of soil erosion
- Pasture helps to improve soil structure
  - By maintaining soil fertility
- Pasture adds nutrients to the soil
  - Leguminous plants fix nitrogen into the soil
- Pasture can also be established to increase production in acidic soils which may not support crop production
- Pasture helps to utilize non-arable land whilst using arable land for crops
- Pasture helps to reduce pests and diseases in livestock
  - When rotational grazing is practised through paddocking

Types of pasture

1. Indigenous/natural pasture

- This refers to naturally growing pasture
  - It is common in communal grazing fields

Some common grass species in natural pastureland depending on altitude

1500m above sea level and below	1500-2000m above sea level	Above 2000m above sea level
• *Hyparrhenia spp* • *Themeda triandra* • *Andropogon schirensis* • *Bewsia biflora* • *Anthephora acuminate* • *Ryhnchelytrum nyassanum*	• *Themeda triandra* • *Hyparrhenia lecomtei* • *Rxotheca abyssinica* • *Monocymbium ceresiiforme* • *Brachiaria serrate* • *Melinis maitilandii*	• *Exotheca spp* • *Agrostis spp* • *Trchypogon spicatus* • *Monocymbium ceresiiforme*

• *Andropogon complectens*	• *Protea spp* • *Rhychelytrum stolzii* • *Rhychelytrum nerviglume* • *Rhychelytrumst uposum*	

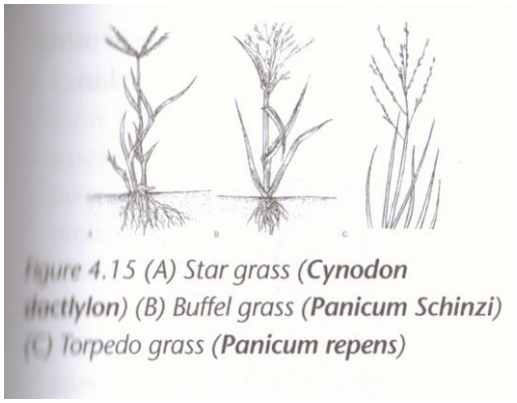


Figure 4.15 (A) Star grass (**Cynodon dactylon**) (B) Buffel grass (**Panicum Schinzi**) (C) Torpedo grass (**Panicum repens**)

Fig.11.1a

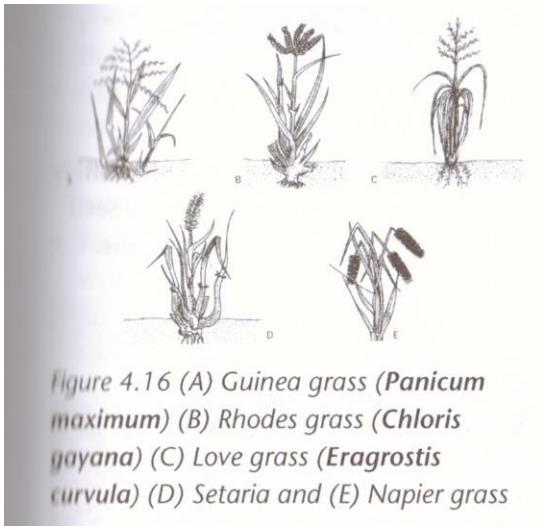


Figure 4.16 (A) Guinea grass (**Panicum maximum**) (B) Rhodes grass (**Chloris gayana**) (C) Love grass (**Eragrostis curvula**) (D) Setaria and (E) Napier grass

Fig.11.1b

Characteristics of indigenous pasture

- They are usually poorly managed
- They have low productivity

2. Exotic/cultivated or planted pasture

❖ This is artificially established or grown pasture

Some common cultivated grasses

- Rhodes grass (*Chloris gayana*)
- Buffel grass (*Cenchrus ciliaris*)
- Napier grass (*Pennisetum purpureum*)
- Guinea grass (*Panicum maximum*)

Some common cultivated leguminous pasture

- *Stylosanthes spp* (Stylo)
- *Centrosema spp* (Centro)
- *Macroptilium spp*
- *Macrotyloma spp*
- *Desmodium spp* (Desmodium)
- *Neonotonia sppp*

Leguminous shrubs grown in some farms

- *Leucaena leucocephala* (Leucaena)
- *Faidherbia albida*

Types of cultivated pasture

a) Pure stand

- This is the pasture where only grass or legumes are grown

➢ Pure stand of grass
➢ Pure stand of legumes

Advantages of pure stand pasture

- It is easier to control weeds using herbicides
- There is better establishment as there is less competition for nutrients, space and light
- It is easier to collect seeds from pure stand

Disadvantages of pure stand pasture

- In case of outbreak of pests and diseases the farmer has nothing to reply on
- Low yield per unit area
- There are more cases of bloat in animals if the pasture crops are leguminous
- The feed may not be very palatable if fed to livestock

b) Mixed pasture

- This is the pasture where grasses and legumes are grown together
- Mixed pasture are usually more

Advantages of mixed pasture

- Grass-legume pasture have high nutrient value
- They improve soil fertility due to nitrogen fixation by the legumes and
  - ➢ there is less usage of nitrogen fertilizers
- There is high yield per unit area

- Animals are less prone to bloat when grazed on mixed pasture
- There is guaranteed yield in case of failure of one crop
- Grass-legume pasture is more palatable to livestock
- There is maximum soil exploitation as different crops have different soil nutrient requirements

Disadvantages of mixed pasture

- It is difficult to control weeds using chemicals
- There is undesirable competition for nutrients, light and space especially when incorrect seed rate is used
- It is difficult to collect seeds from mixed pasture

Pasture establishment

Factors to consider when establishing pasture

- Fertility status of the soil to support pasture growth
  - ➢ It enables the farmer to know the amount of fertilizer or manure needed to improve soil fertility
- Condition of the land
  - ➢ Should be free from waterlogging
- Location of the land
  - ➢ Should be near a source of water
- Distance from the milking parlour or shed
  - ➢ For dairy cattle

Methods of pasture establishment

1. **Broadcasting**
   - This is the act of scattering seeds by hand or using seed broadcaster

   Steps for broadcasting pasture seeds

   (i) Dividing the field into small plots
   (ii) Dividing seeds and broadcasting them depending on the size of each plot
   (iii) Lightly covering the seeds with soil
   (iv) Adding fertilizer depending on the fertility level of the soil

   Advantages of broadcasting

   - It is less expensive
   - It requires minimal labour
   - It takes a very short time

   Disadvantages of broadcasting

   - Some seeds go to waste as they are blown away by wind. Others may be eaten by birds
     - ✓ This reduces the number of seeds germinating
   - Uneven seed population
     - ✓ Many seeds may fall in one area and fewer seeds in the other

2. **Undersowing**
   - This means planting grass or legume seeds in a field which is already planted with a crop known as a ***nurse crop***, e.g., maize or wheat
   - ➢ Grass or legume plants are grown in spaces between the crop

   Advantages of Undersowing

   - It reduces the cost of initial pasture establishment
     - ✓ By reducing the number of cultivations required
   - It is more reliable
   - It reduces destruction of soil structure
     - ✓ Through reduction of cultivation

   Disadvantages of Undersowing

   - It is difficult to harvest the main crops
     - ✓ Especially when the Undersown pasture has grown quite well

3. **Oversowing**
   - This is the introduction of better grazing pasture species in unimproved grassland without destroying the existing forage cover

NOTE:

During preparation of seed bed for sowing, the existing forage should be reduced in height and density by:

(i) trimming the forage using a mower
(ii) grazing animals on that piece of land

Advantages of Oversowing

- The existing forage protects the seedlings from direct sunlight
- The pasture is improved as different and better species of pasture are introduce into the soil
- There is reduced soil erosion

- It makes maximum use of semi-arable land
- There is minimum loss of grazing
- It maintains soil moisture content
- There is reduced labour and lower machinery investment

Disadvantages of Oversowing

- If planted without mowing, the existing forage will prevent sunlight from reaching the germinating seeds
  - ✓ this causes them to wither or become unhealthy (tillering)
- The growing seeds compete with the existing pasture for nutrients and sunlight
- Higher rodent and insect population
- It requires high management skills

4. Drilling

- This is the sowing of the pasture seeds using a seed drill
- It is the best way of planting seeds for pasture
  - ✓ Seeds are immediately covered with soil
- Fertilizer can also be placed at the same time

Advantages of drilling

- Seeds are sown at the correct depth
- Uniform spacing is maintained
- The seeds required are less than those used in broadcasting

Disadvantages of drilling

- It requires a skilled person to operate the seed drill
- The seed drill required for sowing is expensive

5. Vegetative propagation

- This is the use of parts of the already established or grown plant.
- A reasonable tilth is required during land preparation
- Seed bed should be clean and free from weeds at the time of planting
- Spacing of the vegetative planting materials depends on
  a. *Type of species*
  b. Growth *habit of species*

Advantages of vegetative propagation

- The superior traits in the parent crop are maintained
  - ✓ This ensures that the pasture produced is of high quality
- Large quantities of pasture can be produced easily and faster
- The pasture matures faster

Disadvantages of vegetative propagation

- There will be competition for nutrients from the soil
  - ✓ Since pasture grows faster
- The planting materials are bulky to transport and store
- The planting materials deteriorate quickly
  - ✓ Cannot be stored for a long period of time for planting
- Genetic weakness and traits in the pasture are carried on in the pasture that is being grown

Seed rate

- Seed rate refers to amount of seeds to be used per hectare of land
- It is expressed in kg/ha

Effects of seed rate

- It influences spacing of pasture
- It influences pasture population

Importance of appropriate spacing and plant population

- They increase growth rate of pasture
- They ensure high yields of the pasture that has been grown

Calculating seed rate

$$\text{Seed rate} = \frac{\text{Average weight of one seed x No.of seeds/hole x No.of holes}}{\text{Number of heactares}}$$

or

$$\frac{Expected\ plant\ population\ per\ hectare}{Seed\ size \times purity\ \% \times germination\%}$$

Consider the following:

1. A farmer wants to plant maize on his three hectares farm. One grain of a healthy seed weighs 0.002kg on average. He has prepared 60 rows on his piece of land each having 100 holes.

Calculate the seed rate if he plants 2 seeds in each hole.

Solution

$$\text{Seed} = \frac{\text{Average weight of one seed x No.of seeds/hole x No.of holes}}{\text{Number of heactares}}$$

$$= \frac{0.002\text{kg x 2 x 60 x 100}}{3\text{ha}}$$

= 8kg/ha

2. Calculate the seed rate for a certain grass species where seed size is 200000 seeds/kg, expected plant population is 600000 with 80% and 60% purity and germination percentages respectively.
   Solution

$$\text{Seed rate} = \frac{600000 \text{ x } 1kg}{200000 \text{ x } 0.8 \text{ x } 0.6 \text{ x } 1ha}$$

= 6.25kg/ha

∴ The seed rate for the grass species is 6.25kg/ha.

Factors affecting pasture seed rate

1. Size of the seed
   - Tiny seeds will require lower seed rate as compared to bigger seeds
2. Soil tilth
   - Tilth refers to the condition of the soil in relation to its ability to support pasture growth
   - A seed bed with better tilth promotes better germination rate hence requires lower seed rate as compared to soil with poor tilth
3. Growth habit of pasture method of sowing
   - Pasture species which spreads or produces more shoots or tillers should have lower seed rate
4. Type of pasture
   - A mixed pasture should have lower seed rate as compared to pure stand pasture
   - To avoid over-competition for soil nutrients
5. Method of sowing
   - Broadcasted seeds have higher seed rate than drilled seeds
6. Purity percentage
   - Pure seeds require lower seed rates than those that are contaminated with foreign materials and dirty
7. Germination percentage
   - Seeds which are suspected to be of a lower viability will require higher seed rate

Methods of pasture treatment

1. **Hulling**
   - Hulling is the process of removing the outer covering or husks of a seed
     - It is usually done in legume seeds

Importance of hulling

- It ensures that the seeds grow quickly after they have been planted
- It increases the rate of water absorption by the seed

2. **Scarification**
   - Scarification is a method used in weakening the seed coat or husks of the pasture seeds before planting them

Methods of scarification

(a) Mechanical method
- Used on small amounts of seeds
- Seeds can be rubbed using:
  - ✓ Sandpaper
  - ✓ Timber on a rough cement floor or surface

(b) Hot water method
- Seeds are immersed in hot water (for a few minutes)
- It requires close monitoring
- Seeds are sown immediately after cooling
- To prevent them from germinating before planting

(c) Acid treatment method
- Seeds are immersed into concentrated acid for a specific period of time
- Sulphuric acid is normally used
- It is used on very small amounts of seeds
- It should be carried out in the laboratory

Importance of scarification

- It makes the seed coat permeable to water and air or gases
- It speeds up seed germination when planted

3. **Inoculation**
   - Seed inoculation is the introduction of nitrogen fixing bacteria into a legume seed to help fix nitrogen in the soil

Procedure for inoculating legume seeds

(i) Pour the legume seeds into a clean polythene
(ii) Sprinkle drops of clean water or milk on the seeds to cover every seed
(iii) Scatter the inoculant evenly over the heap of moist seeds and mix thoroughly with clean sticks
- ➢ So that the inoculant covers every seed

(iv) Spread the seeds on a flat surface to dry for one or two hours under a shade
(v) After the seeds are dry, plant them using a suitable method

Precautions during seed inoculation

a) Do not expose the inoculated seeds to direct sunlight
- ➢ Light may kill the nitrogen fixing bacteria

b) Use on inoculants with viable bacteria
c) Inoculated seeds should not come into contact with acid fertilizers

Importance of inoculation

- It ensures that the Rhizobium bacterium is present in the soil to fix atmospheric nitrogen and into the pasture through root nodules
- It ensures that there is an increase in the amount of bacteria available in the soil

4. Pelleting

- ❖ Pelleting is the process of coating seeds with materials or substances that are inert or lifeless to make them uniform in size and shape

Importance of pelleting

- It increases the availability and penetration of oxygen in the soil
- It ensures there is accurate spacing of the seeds when they have been planted
- It ensures low seed rate

Proper time for pasture establishment

- Pasture seeds should be sown early enough in the planting season to achieve better results
- In vegetative propagation, the planting materials should be planted when there is enough moisture in the soil

Causes of failure in pasture establishment

(i) Poor seed germination due to:
- ✓ Planting too deep
- ✓ Poor seedbed preparation or poorly aerated compacted seedbed
- ✓ Using seeds with low viability

(ii) Poor inoculation
(iii) Lack of enough nutrients in the soil
(iv) Unfavourable chemical conditions
(v) Poor drainage
(vi) Pests and diseases if not controlled

Pasture management

- Pasture management includes all the practices undertaken to maintain the productivity of pasture

Things to consider for successful maintenance of high pasture yield

- Production of sufficient amounts of herbaceous vegetation to meet the feeding requirements of the animals throughout the year
- Pasture produced on the farm should be eaten with no waste
- Pasture should be utilized when its quality is sufficiently high for high yields from the animals
- Sustainable methods of pasture management should be employed

Activities in pasture management

1. Application of manures or fertilizers

- Apply the correct type and amount of fertilizer during pasture establishment for proper growth rate of the pasture

  - ✓ Soil should be tested to determine its level of fertility

- Top dressing should be done at the onset of the rains, with split application of nitrogen fertilizers

Importance of top-dressing

- o To improve the nutrient value of the pasture
- o To replenish soil nutrients
- o To increase the total yield of the pasture
- o To improve the physical characteristics of the pasture such as structure
- o To correct the chemical properties of the soil such as pH

2. Weed control

Common pasture weeds

(i) Thorn apple (*Datura stramonium*)

Fig.11.2

- It is an annual herb
- It is common in arable land waste lands
- It has large alternate ovate leaves with toothed margins and white flowers which are funnel shaped
- The stems are erect and can grow as high as 150cm.
- It has thorny fruits which contain several dark brown seeds

(ii) Sodom apple (*Solanum incanum*)

Fig.11.3

- It is a perennial shrub found in pasture lands, marginal areas and at roadsides all over Africa
- It has pricky, erect, branched stems that grow as high as 1.8m
- It has ovate leaves with a wavy margin
- It bears purple blue to white flowers with almost spherical berries which are yellow when ripe
- It has well developed rhizomes

(iii) Lantana/Tick berry (*Lantana camara*)

Fig.11.4

- It is a perennial shrub
- It forms impermeable thickets in wastelands and grasslands receiving adequate annual rainfall
- the stems are erect and can grow up to 3.6m high
- the leaves have toothed margins and rough upper surfaces
- the most troublesome varieties have flower heads with pink-purple flowers
- some have yellow, pink, red or white flowers
- it produces green fruits which ripen into shiny black clusters
- its leaves are poisonous to livestock

Ways of weeding in pasture

a) Clearing the pasture land of all the vegetation and weeds before planting, e.g.,
b) Planting seeds that have a high purity percentage
c) Uprooting the weeds from the growing pasture mechanically using the hand
d) Applying herbicides that are not harmful to the livestock, e.g., 2.4-D, Paraquat, MCPA and Simazine

Reasons for weed control

(i) Weeds compete with forage crops for nutrients, moisture, space and sunlight which ultimately affect the overall performance of the forage crops
(ii) Weeds interfere with proper forage establishment thereby prolonging the establishment and maturity period
(iii) Presence of weeds reduces the quality and overall herbage yields
(iv) Some weeds may result in livestock poisoning if fed on
(v) Weeds shorten the life span of a forage
(vi) Some weeds taint the colour and flavour of milk , e.g., wild onions

3. Controlling pests and diseases

- Pests and diseases that attack pasture lead to:
  (i) stunted growth of pasture
  (ii) low productivity of pasture
  (iii) death of pasture
- Pests also damage pasture

Ways of controlling pests and diseases in pasture

a) Rotational grazing
   - It reduces build-up of pests and diseases

b) Spraying chemical substances that are not harmful to the health of livestock
   - ➢ It eliminates pests and diseases

4. Grazing livestock

- Grazing of livestock should be controlled
  - ➢ To ensure that pasture is not destroyed
- Stocking should also be controlled
  - ➢ Avoid overstocking or understocking

❖ Overstocking leads to pasture deterioration due to overgrazing

❖ Understocking leads to:

(i) Accumulation of inedible materials in pasture

(ii) The forage becoming woody

5. Controlling burning of pasture

- Burning pasture is not recommended
- Burning of pasture leads to death of beneficial micro-organisms in the soil
  - ➢ Reduction in microbial activities leads to soil infertility and destruction of soil structure

Grazing animals

❖ Grazing on pasture is termed as ***defoliation***.

Phases of defoliation

(a) Early defoliation

- This is grazing livestock on pasture which are less than 4 weeks old

Effects of early defoliation

- It has low dry matter yield hence low in nutrient
- It has low crude protein yield
- It has high dry matter digestibility but low digestible nutrients
- High moisture content
- It leads to gradual weakening of the stand and reduction in the life of the stand

(b) Late defoliation

- It refers to first grazing of livestock on pasture which are more than10 weeks old.

Effects of late defoliation

- High cellulose content
- High dry matter content
- High lignin content
- Low crude protein content
- Low leaf stem ratio hence reduced palatability
- Low digestibility

Limitations of overgrazing

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

Limitations of undergrazing

- Gradual increase of weeds
- Leads to wastage of forage as animal foul graze (they pick some pasture as they trample on the rest)
- Due to selective grazing by the livestock, forage gets too woody and unpalatable
- Decline in regrowth of pasture
- Low growing pasture plants are smothered due to shading effects

Grazing systems in pasture management

1. Zero grazing/cut-and-carry/stall grazing

- Animals are confined in their shed
- The forage is cut and brought to the animals in the shed
- It is commonly practised where land is limited

Advantages of zero grazing

- Forage intake is uniform and it is easy to ration fodder for livestock
- Greater yields are achieved from the livestock
- Reduction in energy loss as livestock do not walk long distances looking for food
- It allows higher stocking rate in relation to the amount of land available
- There is quick accumulation of manure
- It is ease]y to control diseases and parasites

Disadvantages of zero grazing

- The cost of establishing the zero grazing unit is high
- Problems of obtaining bedding material and establishing appropriate disposal system
- It requires full time supervision
- There is fast spread of diseases and parasites
- It is labor-intensive

2. **Rotational/paddock grazing**
   - ❖ It is a system where more than one pieces of land is used in grazing livestock
   - The land is divided into sections known as paddocks
   - Livestock are grazed in one paddock then moved to another once the pasture in the current paddock is exhausted
   - The pasture land is given time to re-grow as the livestock feed on pasture in another paddock

Advantages of rotational grazing

- It breaks the life cycles of parasites thus ensuring their control
- Pasture is utilized at the correct stage of growth when it is highly nutritious
- It allows excess pasture to be conserved as hay and silage for later use
- Different management operations, e.g., fertilizer application can be carried out in the paddock when not in use
- Animals affected with diseases can be separated from the healthy ones hence reducing spread of diseases
- There is even and controlled grazing of the pasture
- Animal wastes, e.g., urine and dung are well distributed and decompose into humus making the pasture fertile

Disadvantages of rotational grazing

- It requires fencing and paddocking which may be expensive for some farmers
- It requires that the number of livestock kept be high in order to utilize the pasture effectively
- It requires large tracts of land

3. **Strip grazing**
   - ❖ Strip grazing is the grazing system where livestock are a new place to graze daily
   - The area is divided into paddocks using movable electric fence

Advantages of strip grazing

- It minimizes bloating in livestock since it helps in reducing the intake of pasture by livestock
- It gives more productivity per unit land than the regular rotational grazing
- The pasture is utilized more effectively
- It is comparatively cheaper than constructing a paddock

Disadvantages of strip grazing

- It can only where there is a source of electric power
- It occurs extra costs of electricity on the farm

4. **Continuous grazing**
   - ❖ Continuous grazing is a system of grazing whereby the animals are left to grazing freely on the land without any restriction
   - It is common in areas where communal grazing is practised

Advantages of continuous grazing

- There is a minimum or no investment involved in the establishment of the pasture
- There is high productivity if there is enough pasture
- It is simple to implement and manage
- It is least expensive

Disadvantage of continuous grazing

- It is difficult to control grazing as livestock graze unevenly
- It is difficult to control understocking and overstocking
- The quality and quantity of the pasture is reduced
- There is a build-up of pests and diseases in pasture
- Weeds and other undesirable plants grow in large numbers
- Soil erosion may occur if the pasture is overstocked

5. **Deferred grazing**
   - ❖ Deferred grazing is a system of grazing where livestock are delayed from grazing in a pasture because they already have enough pasture to feed on

- ➢ They are only fed on the pasture if there is shortage of forage, especially in dry season

Advantages of deferred grazing

- It reduces overgrazing
- It leads to an increase in the stocking rate since pasture will be available even when there is shortage

Disadvantages of deferred grazing

- The forage may become woody and thus unsuitable for livestock
- It leads to a reduction in the grazing season and period of grazing

Pasture conservation

Aims of pasture conservation

- ❖ To keep the excess forage for future use
- ❖ To ensure continued distribution and supply of fodder to livestock throughout the year

- ➢ To keep the pasture safe from deterioration

Methods of pasture conservation

1. **Hay making**
   - ❖ Hay making involves reducing the moisture content of the forage crops that have been cut
   - It can be done
     - ✓ Naturally
     - ✓ Artificially

Importance of hay making

- It allows storage of food for livestock without the rise of deterioration through
  a) fermentation
  b) mould formation
  c) decomposition

Recommended moisture content for hay

- hay stored in bales about 20%
- hay to be left loose about 16%

Procedure for making hay

(i) Cut the crop at its highest nutrient value
- ➢ avoid using mature crops as they are too succulent

(ii) Allow the crop to dry in the field for 24 hours depending on the weather condition

(iii) Spread out the cut forage on a dry surface to allow further drying up to 48 hours before baling or making bundles
- ➢ baling should be done 72 hours after cutting

(iv) Stacking the dry material into bales or bundles

Fig.11.5

2. **Silage making**
   - ❖ Silage making is a process in which the forage is preserved with high moisture content through fermentation in air-tight conditions

Procedure for silage making

(i) Cut the crop at the correct maturity stage or maximum nutrient content

(ii) Allow the crop to wilt to acceptable moisture level

(iii) Chop the forage to reasonable sizes and fill in the silo

(iv) Spread the material in the silo evenly and compact well with heavy equipment

(v) Fill the silo up to about 1 metre on the first day

(vi) On the second day, make sure the temperature in the material is about 32.2°C before starting filling

- ➢ Higher temperature shows that more compaction is needed

(vii) Complete the filling on the third or fourth day and cover the silo to ensure that no air gets in

(viii) Dig a trench around the silo to keep surface water away
- ❖ Molasses can be added to the silage material to encourage fermentation of lactic acid

- ❖ Lactic acid leads to the preservation of silage
- ❖ Lactic acid also helps to improve the quality of the silage

Fig.11.6

Effects of too much air in silage making

- Over heating
- Decomposition

Types of silos for silage making

a. Clamp silo

- It is constructed above the ground level with slanting walls
- The sides are made up of pair of timber with soil put in between them or stones and cemented floor

b. Trench silo

- It is a rectangular excavation done under the ground

c. Bunker silo

- it is often made up of concrete above the ground level
- it has perpendicular walls which are suitable for mechanical ensiling

Qualities of good silage

- It should be from high quality forage cut at the proper stage of grow
- It should have a pH of 4.2 or below
- It should have 5 to 9% lactic acid
- It should be free of moulds and bad odours, e.g., ammonia and butyric acid
- It should be green to yellow in colour but not brown or black
- It should have a fine texture but with no sliminess

Advantages of silage making

- There is minimal loss of nutrients in the preserved feed
- It is less dependent on weather conditions for its preparation
- Once ensiled, there are no storage problems, hence can be preserved for long
- Ensiling killing all weed seeds hence discourage the spread of weeds

Disadvantages of silage making

- It requires high level of skills
- It is labour intensive and expensive
- It is susceptible to loss of nutrients through seepage and volatilization
- It is bulky to store and handle
- It must be fed soon after removal from the silo or else it spoils
- Grass loses original taste

Precautions when feeding silage to livestock

- It must be fed to cows after milking

✓ To avoid tainting the milk

- The silo opening must be as small as possible to prevent air from getting in.

✓ A lot of air encourages aerobic respiration which breaks down carbohydrates and reduces the quality of the silage

- Left-over silage must be discarded
- Silage with mould or bad odour should be disposed of

3. Foggage

- Foggage is standing hay or pasture (mainly grass) that is left to grow and dry up in the field for direct grazing in the day season
- Foggage can be from natural pasture or established pasture

Fig.11.7

Factors that affect quality of conserved pasture

- Leafiness of pasture
  - Pasture that is very leafy after growth produced good quality hay or silage
  - Pasture that is woody produces poor quality hay or silage
- Age at which pasture is cut
  - When cut at high nutrient value, the hay or silage will have high nutrient content dry matter content
- Moisture content
  - Hay and silage with high moisture content will turn mouldy and will decompose
  - Very dry hay will break during handling leading to low quantity
- Presence of foreign materials
  - Stones and twigs in conserved pasture lowers its quality
- Method of storage
  - Poor storage lowers the quality of hay or silage
- Weather conditions
  - It is more difficult to prepare and keep high quality hay when the weather is very et than when it is dry
- Pasture species used
  - A pure stand of legumes or a mixed grass-legume pasture will produce high quality feed than using grass alone
  - Some grass species are also more nutritious than others

TOPIC 12: MANGO PRODUCTION

Fig.12.1

- Areas of medium and low altitude in tropics are most suitable for mango production
- Mangoes are originated from
  (i) South Africa
  (ii) East Asia
  (iii) India
  (iv) Philippines

Parts of a mango fruit and its stone

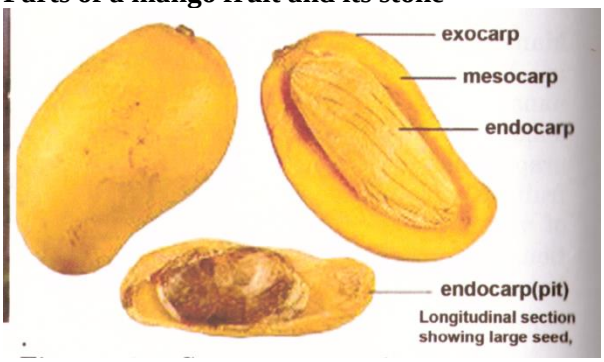


Fig.12.2

Importance of fruits

Fig.12.3

1. ***Nutritional value***
   - Fruits help to keep the body hydrated
   - Fruits lower the risk of illness and diseases, e.g.,
   - Fruits lower the cholesterol levels in the body
   - Fruits clear the skin by opening pores
   - Fruits eliminate pimples
   - Vitamin A in some fruits improves eyesight by preventing night blindness
   - Fruits prevent dry eyes
   - Fruits give the body energy
   - Fibres in fruits help in digestion

2. ***Economic value***
   - Fruits are a source of income to the farmer
   - Fruits provide employment
   - Fruits are a source of foreign exchange to the country once exported
   - Fruit trees can be used as a source of wood once they become unproductive
     - Wood is sold
     - Wood is used in making furniture
   - Barks of mango trees can be sold and used in the process of training hides (due to presence of tannin)
     - Mango tree barks contain tannin

3. ***Socio-economic value***
   - Fruits are used in traditional ceremonies
   - Fruits are offered as gifts
   - Fruits trees provide shade
     - People can sit under trees while resting
   - Fruit trees prevent soil degradation
     - Their roots hold soil together and prevent soil erosion
   - Fruit trees purity the air that we breathe
     - They take in carbon dioxide and release oxygen
   - Fruits have a medical value
     - Their nutrients protect the body against diseases

Varieties of mangoes commonly found in Malawi

1. **Local varieties**
   - They are fibrous (the flesh is stringy)

   a) *Boloma*
   b) *Domasi*
   c) *Dodo*
   d) *Waka*
   e) *Kapantha*
   f) *Kambalata*

   - The first three are big and sweet
   - The next three varieties are *small*, *popular* and *have good flavour*

2. **Exotic varieties**

   a) *Zill*

Fig12.4

- It is a medium size fruit up to 300-400g
- It is oval in shape, has rounded base and rounded apex
- It is an early season fruit
- It has thin skin which is yellow and scarlet to dark red when ripe
- The fruits flesh is yellow, fibreless, have a sweet smell and strong aroma
- They have excellent external qualities and keep well
- The trees grow vigorously and develop large spreading canopy
- They are suitable for all tropical mango areas

b) *Ngowe*

- It is commonly grown in coastal regions of Malawi in the medium altitude areas
- It matures early
- It produces yellow fruits

c) *Keitt*

Fig.12.5

- It is round oval fruit
- It is yellow to light red in colour
- Its flesh is orange to yellow in colour
- It is fibreless except the area that is close to the seed
- Its tree is of medium size
- It matures late
- It is highly productive depending on how it is managed

d) *Kent*

Fig.12.6

- It has oval-shaped fruits
- It is greenish yellow skin in colour
- Fruits mature very late
- The fruit is fibreless, sweet and has good flavour
- It is susceptible to black spot diseases

e) Haden

Fig.12.7

- It is vigorous, large grower with an open rounded canopy
- It is an early season variety and suits hot dry areas
- It is susceptible to anthracnose
- It is a medium sized fruit (400-700g), round to oval shape, good flavour, little fibre
- It is yellow at tip when ripe and crimson blush at base

f) Tommy Atkins

Fig.12.8

- Similar to Haden, but fruit is fibreless with bright red colour as in peach
- Fruit has a small seed
- Its taste is blander, but when ripe, it develops a sweet aroma and is soft to the touch

g) Irwin

Fig.12.9

- It has dwarf tree (can be grown in a container, if desperate for space)
- It is an early season variety
- It suits more areas in Malawi
- The fruit is oblong (up to 12cm long), small to medium size (150-450g), sweet, fibreless, orange to pink colour, purple towards maturity with extensive dark red blush

h) Palmer

Fig.12.10

- It has a medium to large tree
- It is a late season variety
- It is susceptible bacterial black spot
- Its fruit is oblong, ovate , large (600-700g), fibreless, orange to pink colour with extensive dark red blush

i) *Anderson*

Fig.12.11

j) *Apple*

- It grows well in the coastal and lowland areas
- It is susceptible to rust in high altitude areas
- It has round, apple-shaped fruits
- The flesh is yellow to orange in colour

Site selection for mango production

A site suitable for mango production should be identified before planting time

Factors to consider when selecting a site for mango production

(i) Ecological requirements

- Mangoes do well in the lowland to upper middle altitude areas of 1500m above

(ii) Temperature

- Mangoes require a temperature of 15°C
- At lower temperatures the quality of fruits declines

(iii) Rainfall

- Mango production prefers an annual rainfall of 850 – 1000mm
- Flower production is facilitated by a dry or cold spell
- Rain during flowering reduces fruit set
- ✓ An established mango tree is relatively drought resistant provided the tap roots have access to the water

(iv) Soil requirements

- Mango trees preferably require a deep fertile soil
- Soils should be loamy and adequately drained

Preparing a site for transplanting mango seedlings

Three main activities

a) Land clearing

- Bushes and weeds should be removed and roots uprooted
- Land should be well cultivated

b) Making planting holes

- Holes should be 60cm by 60cm
- Spacing should be 12m by 12m

c) Manure and fertilizer application

- Mix the topsoil with about 20kg of well decomposed manure and 125g of triple sulphate or ammonium phosphate before filling the hole
- Fill the hole half way with topsoil

Transporting mango seedlings

1. Water the hole before transplanting mango seedlings
   - ➢ To ensure that there be root and soil contact after transplanting
2. Lift the seedling slowly and carefully from where it has been grown and put it into the hole
3. Fill the hole with soil mixed with compost manure
   - ➢ Do this carefully and use a trowel to avoid damaging the seedling
4. Water the seedling directly immediately after transplanting
5. Add mulch around the seeding (dry grass or leaves)
   - ➢ To reduce erosion
   - ➢ To conserve moisture and soil
   - ➢ To control weeds

Weeding the mango orchard

- ❖ An orchard is a site where fruit seedlings have been transplanted so that they can grow permanently

Methods of weeding

(a) Physical weed control

- This involves uprooting weeds by hand
- It can be successful if:
  - ✓ Weeds are uprooted before flowering to prevent seed multiplication
  - ✓ Weeds are uprooted before their roots intervene with those of crop plants

- ✓ The uprooted weeds are effectively disposed so that there is no chance for regeneration
- ✓ The soil is moist enough to enable the uprooting of the entire weed
- ✓ The weather is sunny so that the uprooted weeds will quickly dry out and die

Advantages

- It is efficient for removing weeds on planting stations without any injury to plants
- It require little or no investment in farm tools
- It does not require specific skills
- It is cheap where labour is in large numbers
- It is a sure way of killing weeds if the entire root system is removed

Disadvantages

- It is very slow and not suitable for large farms
- It is very tiresome
- It may not be effective if the weeds break up leaving the roots to produce new shoots
- It may result in transplanting the uprooted weeds if they are not effectively disposed of
- The weeds have enough time to use the food crop as hand weeding waits until the weed is at stage where it can be pulled out

(b) Cultural weed control

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

Advantages

- It is easy to use
- It is cheap
- It does not require extra effort as normal husbandry practices are used

Disadvantage

- It does not control all weeds

(c) Biological weed control

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

Advantages

- Make use of natural enemies
- Does not require any labour other than just introducing the pests the field

Disadvantages

- Requires careful attention to maintain balance between the pests and the weed
- It is difficult to breed host-specific pests for weed control
- Cannot be used to eradicate (get rid of) of weeds

(d) Chemical weed control

- This involves use of substances or compounds which destroy the weed but not affect the crop, e.g., herbicides

Classification of herbicides

Criteria for classifying herbicides are:

- ***In terms of use***
  - i. Selective herbicides: destroy a particular group of plants without harming other plants, e.g., Dalapon kills monocots (grasses) while 2,4D acid and 2,4,5-T kill broad leaved weedsk
  - ii. Non-selective herbicides: kill any plant, e.g., Paraquat

- ***In terms of mode of action***
  i. Contact herbicides: kill the weeds when they are in direct contact with them, e.g., Bentazone and Prapanil
  ii. Translocated (systematic) herbicides: get translocated to other parts of the plant through the vascular system (xylem and phloem) to kill the weeds, e.g., Atrazine, Simazine and Diuron
  iii. Soil sterilants: prevents germination and growth of weeds, e.g., Bromacil

- ***In terms of time of application***
  i. Pre-planting herbicides, e.g., methyl bromide
  ii. Pre-emergence herbicides, e.g., Lasso 18
  iii. Post-emergence herbicides, e.g., 2,4-D

Advantages of chemical weed control

- Reduces early weed competition – pre-emergence herbicides
- Reduces labour demand for weeding
- Ensure timely control of weds and cultivation of large hectarage
- It is quick in controlling weeds

Disadvantages

- It can destroy crops if not properly diluted
- It is expensive to purchase herbicides and equipment for application
- Some herbicides can harm people or livestock
- It is less effective if the application is followed by rainfall
- It needs skill especially on handling and application of chemicals

(e) Mechanical weed control

- This is the use of farm tools and farm implements to control the weeds, e.g., hoes, ploughs, cultivators, sickles, mowers and slashers
- Processes of mechanical weed control include:
  - ✓ Slashing to cut down weeds. It is used in well-established woodlots or orchard
  - ✓ Hoeing out weeds. This is scrapping or lifting weeds out of the soil using a hoe
  - ✓ Trimming down the weeds to reduce the height of weeds, e.g., star grass
  - ✓ Digging out weeds. The weeds are buried into the soil using farm implements

Advantages of mechanical weed control

- Faster so large plots can be weeded in time
- Less tiring than physical weeding

Disadvantages

- It is expensive since it uses equipment
- It may not completely eliminate weeds
- It may require skill to some of the equipment
- It may result in some crops being cut down
- It cannot control weeds within the rows of crops

(f) Legislative weed control

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

Advantages of legislative weed control

- It prevents strange weeds from entering the country
- It is free to the farmer

Disadvantages

- Smuggling of the products makes the system less effective
- It is difficult to enforce
- It does not control weeds in individual farms
- It covers only selected weeds

Pests that attack mangoes

1. **Fruit flies**

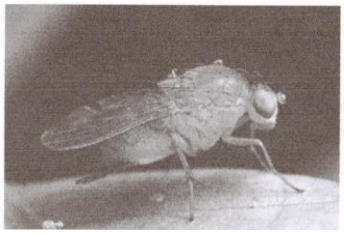


Fig.12.12

- They look like wasps
- They are red-brown in colour with yellow marks
- The female fly usually bores holes in the mature mango fruits and lays eggs there
- The eggs hatch after 2-3 days and develop into larva
  - They destroy the fruits by feeding on the flesh

Controlling fruit flies

- Use approved chemicals to spray the fruits
- Fallen fruits should be collected to prevent them from accumulating under the tree
  - ➢ They provide a breeding ground for the fruit flies

2. **Mango scales**

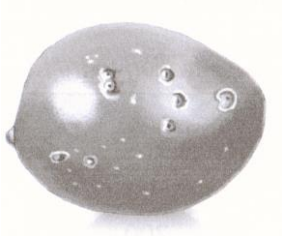


Fig.12.13a

Fig.12.13b

- These are small insects which vary in colour and shape
- They are immobile insects
- Female insects have neither wings nor legs
- They usually resemble small shells
- They lay eggs under the shell which hatch and move into the fruit
- They usually suck the juice or sap from parts of the mango plant
- They cause
  - (i) Yellowing of leaves
  - (ii) Poor growth of the mango plant
- The attacked fruits usually drop before growing to maturity
- They secrete honeydew which helps in development of sooty mould on leaves

Controlling mango scales

- Introducing ladybirds and wasps to feed on the insects
- Spraying trees with appropriate chemicals
- Trimming the affected branches, leaves and removing affected fruits if the attack has been detected early

3. **Mango stone /seed weevil**

Fig.12.14a: *An adult mango stone weevil*

Fig12.14b: *Mango stone larva*

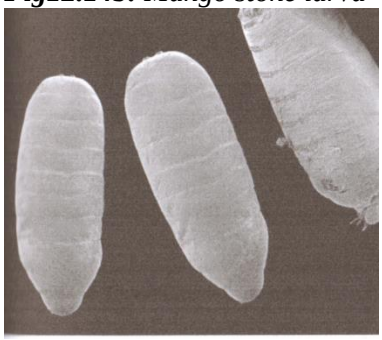


Fig.12.14c: *Mango stone pupa*

- Hey are dark brown or black in colour with grey markings
- The female weevil lays eggs on the fruits that are ripening
- They make holes in the fruit
- They feed on the pulp, seed coat and later on cause damage on the seed or stone

- They pulp is usually discoloured in the area that is affected

Fig.12.15: *Sign of mango stone weevil*

Controlling mango stone weevil

- Affected fruits should be plucked and removed
- Spraying the mango plant with approved insecticides
- Digging the soil to control the weevils that are hibernating

➢ so that they are exposed and eventually die

4. Red-banded thrips

Fig.12.16

- These are insects with light-coloured bodies
- They have a red band around the abdomen
- The eggs are laid on the lower surface of the leaf and then covered with a fluid
- The fluid dries and forms a cover that protects the eggs
- They are hatched and suck sap from the leaves
- They can attack the fruits in severe cases

Controlling red-banded thrips

- Constantly checking the lower surfaces of the leaves for any signs of infection
- Spraying the mango plant with the appropriate insecticides if detected any sign of infection

5. Mealy bugs

Fig.12.17

Diseases that affect mangoes

1. Anthracnose/Blossom blight

- It is a fungal disease

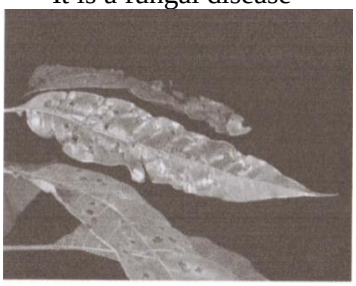


Fig.12.18a

Fig.12.18b

Signs

- Dark sunken spots on affected leaves, stems and ripe fruits
- Pinkish spots on the fruits which later become black
- The fruit may become punctured in the areas affected

Controlling anthracnose

- Spraying the spotting leaves with approved fungicides
- Keeping the mango orchard clean through pruning
- The leaves and branches that have the disease should be trimmed and burnt

2. **Powdery mildew**

Fig.12.19

- It is a serious disease
- It is a fungal disease
- It reduces the yield of the mango plant

Signs

- Powdery substances on leaves, the midrib, young fruits and the flowers
- Premature dropping of fruits and flowers

Controlling powdery mildew

- Spraying the orchard with appropriate fungicides

➢ Strictly follow the instruction on the fungicides from the manufacturer

Pruning

❖ Pruning means cutting unnecessary or unwanted branches from the tree

Characteristics of branches that require pruning

- Overlapping and inter-locking branches
- Diseased, dried and weak branches
- Low branches too close to the ground
- Excessive internal branches
- Weak shoots among overcrowded terminal shoots (they are trimmed to retain two healthy shoots

Reasons for pruning

- To increase growth rate by reducing intra-plant competition for nutrients
- To control tree size and shape
- To open up the structure for good air flow and adequate internal light
- To minimise disease risk

Harvesting mangoes

a) Fruit development

- Generally, mango trees bear fruits 4-5 years after planting
- Grafted plants should not be allowed to bear fruits in the first three years to prevent lodging of the young tree
  - ➢ Flowers during this period should be trimmed
- Fruit takes 120-140 days after fruit set to mature

b) Maturity test signs

- Skin colour: the outer appearance of the mango fruit develops a lighter colour
- Flesh colour: the internal flesh turns light yellow
- Specific gravity: a mature fruit sinks in water because its specific gravity is greater than 1.0.
  - ➢ An immature fruit floats

c) Picking the fruit

- Pick fruits before 10:00am or after 16:00pm
  - ✓ To keep them fresh for longer shelf life
- Harvest fruits with a sharp knife keeping 3-5cm pedicel (fruit stalk)
  - ✓ An intact pedicel avoids oozing of latex on fruit surface, spoiling the appearance, development of black spot and entry of pathogens
- Fruits are harvested by hand and collected in a bag
- Fruits should not fall to the ground to avoid bruising
  - ✓ To maintain quality
  - ✓ To reduce chances of fungal attack

TOPIC 13: BREEDS OF CATTLE

Reasons for keeping cattle in Malawi (purposes)

- For dairy
- For beef
- For draught (power)

Dairy cattle

These are cattle that are kept mainly for milk production.

Longitudinal section of a mammary gland

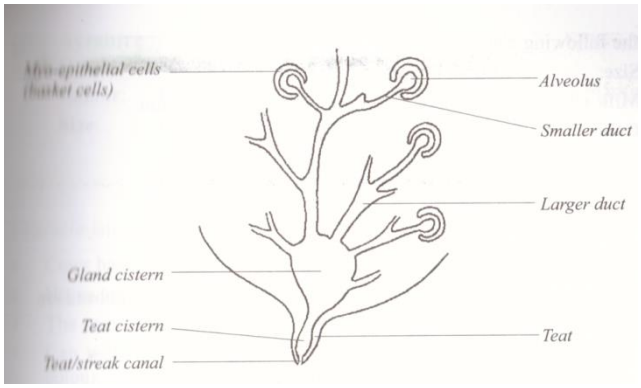


Fig.13.1

Breeds of dairy animals in Malawi

1. Malawi Zebu

- This is an indigenous breed of cattle
- Currently, it has been extensively crossed with exotic breeds as well as other local crosses

Characteristics

- Small body size
- Slow growth rate
- Long calving intervals up to 540 days
- Average milk yield is 900-1000kg per lactation period
- Black, brown or white in colour

2. Jersey

- They originated from Jersey Island in the England Channel, off the coast of France

Characteristics

- They vary from light brown to black in colour
- The muzzle is usually black with a light-coloured ring around it
- They are the smallest of all exotic breeds
- They have huge udder and good conformation
- They produce about 2700kg of milk per lactation period (305 days)
- Their milk has the highest butter-fat content of 5.3%
- They are hardy animals which withstand heat
- Their maintenance cost and food requirements are low
- They do well on good or poor pasture
- The calves are small at birth but mature within 24 to 26 months
- The bulls tend to be violent

3. Guernsey

- They originated from Guernsey Island in the English Channel, off the coast of France.

Characteristics

- They are fairly big animals
- Mature animals weigh about 410kg
- Their colour varies from yellowish-brown to almost red with white markings on the face, legs and switch
- Their milk is golden yellow in colour.
- They produce up to 3600kg of milk per lactation period
- Their milk has about 5% butter-fat content
- They are docile
- They are not as hardy as the Jersey
- The calves are small at birth, weighing about 30kg.

4. Friesian/Holstein

- They originated from Holland

Characteristics

- They are black and white in colour
- They are the largest of the exotic dairy breeds of cattle
- A mature cow weighs about 550kg
- They produce about 5000kg of milk per lactation period
- Their milk is white in colour
- Their milk has a butter-fact content of about 3.5%
- The cows are docile and are good grazers
- They produce large calves weighing between 30 and 40kg
- The calves mature about 30 months

5. Ayshire

- They originated from Scotland

Characteristics

- Its colour varies from red with white markings to white with red markings
- It is a medium breed
- Mature cows weigh about 450kg
- It is a good grazer
- It is a hardy animal that can thrive on relatively poor pasture
- It produces about 4000kg milk per lactation period
- Its milk has a butter-fat content of 4%
- The calves weigh between 30 and 35kg at birth
- Heifers may calve for the first time at 30 months of age

6. Brown Swiss

- It originated from Switzerland

Characteristics

- It is a large breed
- It has large bones
- It is mainly brown in colour, with some variations ranging from light brown to almost black
- They have a lifetime milk production capacity of about 20000 to 25000kg

7. Fleckvieh

- It originated from South of Germany

Characteristics

- It is very resistant to diseases
- Ticks and tsetse flies cannot penetrate its thick skin
- The milk yield is about 7000kg per lactation period
- Their milk has a butter-fat content of 4.13%
- They do well on grazing pasture as well as under zero grazing units
- Their bull calves grow very fast and reach about 500kg within 6 months

General characteristics of dairy cattle

- Their bodies are wedged or triangular-shaped
  - ➢ They have long, lean necks and a wide body capacity
- They have a large body capacity
  - ➢ Long, deep and wide
- They have large udders which have protruding mammary veins
- They have long, lean and smooth neck
- They have large stomach which enables the animals to feed heavily
- The udder is firmly attached and not pendulous
- Teats are uniform in size, well-spaced and long
- They have a straight top line
- They have wide and well-set hind quarters which give room for the large udders
- They have thin bodies which carry little flesh as compared to beef cattle
- Most dairy cattle are docile and have a mild temperament

Management practices for dairy production

a) Housing

Structures required

(i) Milking shed or parlour (Dairy shed)

- A milking parlour is a structure where milking takes place

Types of milking parlour

- Permanent milking shed
- Movable milking shed

Factors to consider when constructing a milking parlour

- It should have a resting area
- It should have an area for the animal to do exercises
- It should have adequate feeding and water space
- Separate the milking area from the feeding, watering and exercise areas
- It should have feed, milking equipment and drugs stores
- Calf pens must be near the dairy shed
- Provision for proper waste disposal
- It should have concrete floor in the milking section, feeding, watering and exercise areas
  - ✓ To withstand the weight of the cattle
  - ✓ To facilitate cleaning

Maintenance of a dairy shed

- Repair worn out or broken parts immediately they are noticed
- Clean it regularly with clean water, detergents and disinfectants

- Ensure proper drainage in the surrounding area
- Ensure proper ventilation

(ii) Calf pens

- These are structures for housing calves

Types of calf pens

- Permanent pens
- Movable pens

b) Selection of breeding stock

- Breeds should withstand climatic conditions of the area

c) Breeding

- Breeding should be done regularly to be able to get at least one calf a year
- A farmer should identify signs of heat in cows to breed them at the correct time
- The dairy cow should be given a resting period of 60-90 days after calving and then mated on the third month of calving
- Heifers should be bred at an average age of 18 months
- Heavy breeds should attain 280-320kg while light breeds should be 250-270kg at the time of service
- Proper feeding is of paramount during gestation by giving concentrate supplements to increase milk yields in lactating cows
- Heifers during gestation should also be fed well as they are still growing

Ways of breeding

(i) Natural
(ii) Artificial insemination

d) Milking the cow

Cross-section of a cow's udder

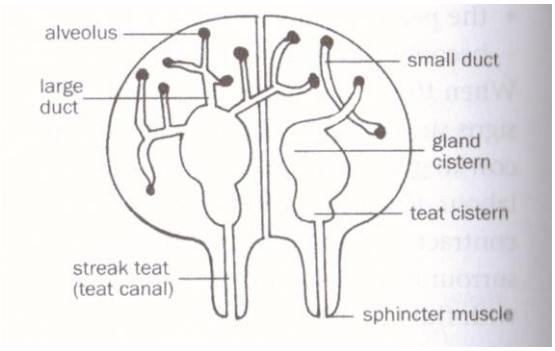


Fig.13.2

- Milking is the removal of milk from the udder of a ruminant animal after it has calved
- Milking should start soon after the cow calves
- Drying off should be done after seven months of pregnancy
- Drying off a cow is a management technique of gradual stopping to milk a lactating cow, especially when milk production is low

Ways of milking a cow

(i) By hands
(ii) Using a milking machine

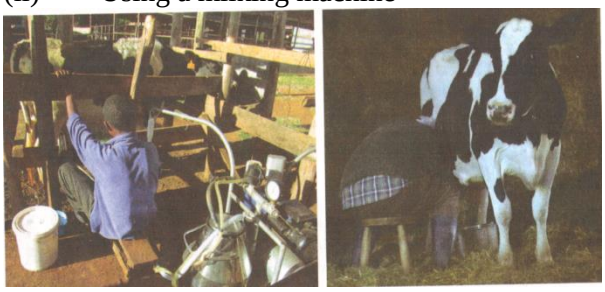


Fig.13.3

The process of milk letdown

When the dairy cow hears the sound of milking churns or cry of a calf the pituitary gland secretes a hormone oxytocin which is released into the blood stream. As oxytocin reaches the udder region, it causes the basket cells (myo-epithelial cells) to contract, hence squeezing milk from the lumen of alveoli secretory cells into the smaller ducts. From smaller ducts, milk flows into large ducts and is stored in the cistern gland and then into teat cistern. Upon milking the cow, the milk is then squeezed through the teat canal and is let out through the sphincter muscle

Relationship between milk yield and foetal growth in a lactating cow

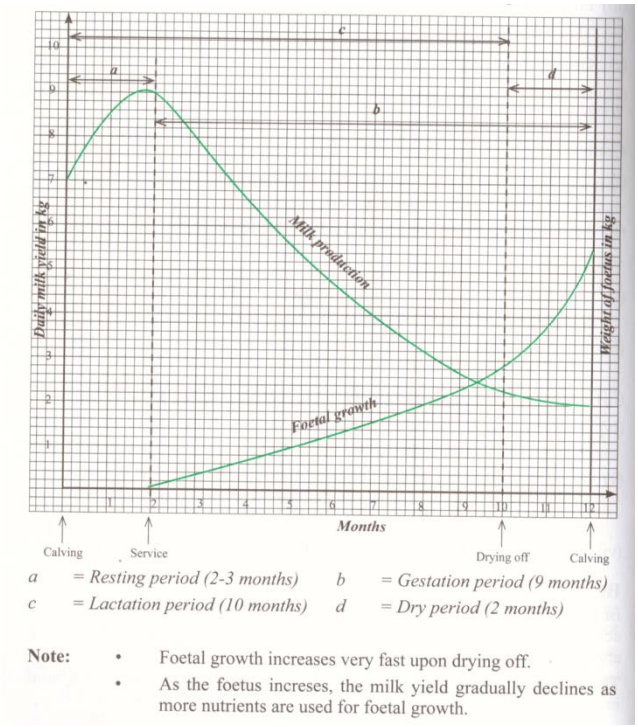


Fig.13.4

Factors affecting milk yield

- Excitement: releases adrenaline which inhibits letdown
- Period of lactation
- Age of the cow
- Character of the cow
- Season/time of the year
- Treatment of the cow
- Feed given to the animal during milking
- Milking method
- The breed of animal
- The condition of the kraal
- Diseases; mastitis, milk fever
- Onset of heat
- Stage of foetal development
- Frequency of milking

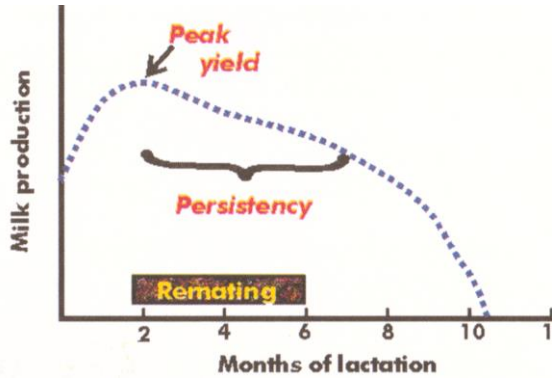


Fig.13.

Beef cattle

- These are breeds of cattle kept mainly for meat production

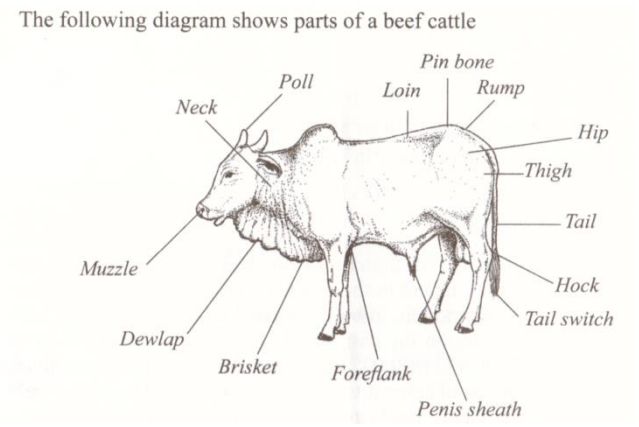


Fig.13.6

Common breeds of beef cattle in Malawi

8. Malawi Zebu

- This is an indigenous breed of cattle
- Currently, it has been extensively crossed with exotic breeds as well as other local crosses

Characteristics

- Small body size
- Slow growth rate
- Long calving intervals up to 540 days
- Low milk and meat production
- Black, brown or white in colour

9. Hereford

- They originated from England in Hereford country

Characteristics

- It is red in colour with white face, breast and underline
- It is low-set and muscular, compact and broad
- It is a good converter of feed into meat
- A mature bull weighs 1000kg and the cow weighs 850kg
- They are either horned or polled

10. Aberdeen

- They originated from northern Scotland

Characteristics

- It is uniformly black in colour
- It has a smooth coat of hair

- They are blocky, muscular, low-set, compact and cylindrical in shape
- A mature cow weighs 750kg while a bull weighs 900kg
- They are polled in nature
- They are fairly resistant to certain eye diseases
- They calves are small at birth but grow fast and catch up with calves of larger breeds at the time of weaning

11. Brahman

- It is a breed of Zebu cattle

Characteristics

- They are grey or red in colour with a black tail switch and black pigmentation on their noses, tips of ears and hooves
- Bulls weigh 800 - 1100kg live weight while cows weigh 500 - 700kg live weight
- At birth, calves weigh 30 - 33kg live weight
- They have a large hump and dewlap
- They are horned but some could be polled
- They have a great ability to withstand heat due to its smooth coat
- They are more resistant to parasites and tropical diseases
- The cows have good mothering ability

12. Sussex

- They originated from Sussex area of Britain

Characteristics

- They are pigmented skin and uniform red in colour
- They are medium sized
- They survive under harsh conditions due to their non-selective grazing habits and superior heat resistance
- They are early maturing
- They are good in milk production
- They have high fertility

13. Afrikander

- They originated from South Africa

Characteristics

- They are deep red in colour
- They have long spreading horns
- They have a small hump

14. Simmental

- They originated from Switzerland

Characteristics

- They are light red with white patches in colour and he head is always white
- They are very large and heavy breed
- They have a fast growth rate
- They are well fleshed

15. Charolais

- It originated from France

Characteristics

- It is white or creamy in colour
- It is the largest of all exotic beef breeds
- A mature breed weighs up to 1200kg and a cow weighs up to 1000kg
- They have compact bodies
- They have double-muscle in the hind quarters
- The calves grow fast and mature early
- It is ideal for cross-breeding

16. Galloway

- It originated from Scotland

Characteristics

- It is black in colour
- It has long curly hair which makes it resistant to cold weather
- It is the smallest of all exotic breeds of beef cattle
- It is very hardy
- It is polled
- It has short legs and a blocky compact body

17. Santa Gertrudis

- It originated from America

Characteristics

- They are large animals
- A mature cow weighs about 800kg and a bull weighs about 1000kg
- They are cherry-red in colour
- They have loose hides that fold
- They can tolerate heat and poor pasture conditions

18. Shorthorn

- They originated from England

Characteristics

- Their colour ranges from red to white while others have a combination of the two colours
- They are large, rectangular and compact in appearance
- Some are polled while others are horned
- A mature cow weighs about 850kg while a bull weighs about 1000kg

19. Boran

- They originated from Somalia and Ethiopia

Characteristics

- They are hardy and adaptable in harsh environmental conditions
- Their colours vary a lot but white, grey and red breeds are common
- They have large hump and dewlap
- They have deep, compact and wide bodies
- They have long legs and wide, drooping rumps
- A mature bull weighs up to 650kg and a cow weighs p to 450kg
- They are very hardy animals and can walk long distances in search of pasture and water
- They are more resistant to tropical diseases
- They grow slowly and mature late
- Heifers calve for the first time at 30 months of age

General characteristics of beef cattle

- They have deep bodies with short legs that are well placed apart
- They are blocky in shape and have relatively heavy hind quarters
  - Their bodies are well-fleshed
- They have strong and well developed muzzle to withstand rough pasture
- The top and lower lines of their bodies are more or less straight with the breast protruding forward
- The hips and loins are well fleshed
- They grow fast and mature early
- They are strong and robust
  - This enables them to cope well in a harsh environment

Management practices for beef cattle

a) Selection of cattle for breeding

- Select cows with beef conformation and characteristics
- Heifers should be 250-260kg
- Bulls should be healthy and vigorous and 18 months of age or older
- Cows take nine months to calve

b) Rearing young animals

- Calves should be allowed to stay with their mothers to breastfeed
- Calves should be dehorned within the next two months after birth
- Male calves selected for breeding are castrated
- Calve should be weaned at 6-8 months of age by separating them from their mothers
- Drenching should be done regularly to control worms
- Fattening heifer and bulls selected for beef should start at 18 months of age

c) Stocking rate

- The stocking rate of beef cattle is determined by the amount of grass or pasture available during driest periods of the year

d) Culling

- Culling is the removal of unproductive animals by selling them

Factors to consider when culling

- Poor breeders which are barren
- Cows that produce weak or small calves
- Old cows past 10 years
- Cows with poor maternal instinct
- Parents of slow grazing calves

e) Feeding beef cattle

- During dry season, beef cattle should be given supplementary feeds to maintain good body weight
- Less or poor quality of grass slows down the growth rate of beef animals

General management practices for cattle

1. Housing

Reasons for housing cattle

- To protect them from extreme climatic conditions, e.g., rain, heat and direct light from the sun
- To protect them from predators and thieves

Housing systems for cattle

a) Loose housing system
   - ✓ Cattle are kept in a big barn which is filled with straw.
   - ✓ It is economical to the farmer

b) Cubicle housing system
   - ✓ Cattle are kept in cubes
   - ✓ It is easy to clean
   - ✓ It reduces the spread of diseases
   - ✓ However, it is expensive

Characteristics of a good cattle house

- The house should be free from draughts, e.g., cold or high temperatures
- It should provide proper drainage of urine by either having sloping cemented floor or wood with spaces
- It should have good ventilation with windows on the windward side of the house and open space fitted with wire mesh on the walls facing each other
- It should have waterproof roof
- It should have dry beddings on the floor in case the floor is not raised which should be replaced frequently
- In case of zero grazing, feeding and water troughs should be where the cattle can feed and drink water easily

2. *Feeding*

Suitable feeds for cattle

- Roughages, e.g., Napier grass, maize stovers, banana stems, sweet potato vines, hay and silage are the main feed for cattle.
- Good quality roughage is essential in milk production, e.g., Napier grass which is very nutritious for dairy cows
  - ✓ Napier grass should be cut when it is 60-90cm tall
- Roughages, e.g., maize stovers, banana stems, Napier grass and silage have very little crude proteins
- Animals fed on low protein roughages should also be fed on protein rich feeds, e.g., desmodium, sweet potato vines, and fodder tree leaves like bananas and Lucerne
- Cattle should also be fed on concentrates
- Concentrates include dairy meal, brewer's waste (dregs), rice bran and meal cakes
  - ✓ Dairy meal or dairy cubes are more balanced concentrates for milk production
- Maize bran and maize germ are concentrates rich in energy
- Copra cake, cotton cake, sesame cake and brewer's waste are concentrates rich in proteins
- Cattle should also be given mineral block to lick
  - ✓ It provides them with essential minerals and vitamins

3. *Parasite and disease control*

Parasites

Types of parasites that attack cattle

(i) Ectoparasites

❖ These are external parasites

a) Fleas

- Fleas are wingless insects with flat bodies.
- They have strong legs with which they leap to great distances
- Their bodies are covered with bristles which point backward and enable them to hold onto the host and move forward
- They suck blood from cattle and cause itching

Control/treatment measures

- Spraying cattle with insecticides
- Removing the infected beddings
- Spraying breeding places paying attention to cracks and hidden places
- Dusting cattle with dusting powders
- Applying a mixture of kerosene and lard which makes fleas to fall on the floor, then cleaned out and burned

b) Lice

- Lice are small wingless, biting and blood-sucking parasites that live on the skin of cattle
- Sucking lice have a narrow head with mouth parts adapted for penetration into the skin when sucking blood
- They cause irritation and the cattle scratch, bite and rub their skins a lot
- They lead to reduced weight gain in cattle
- They also cause damage on the skin of cattle.

Control measures

- Spraying cattle with suitable acaricides at least twice
  - The first application is to kill the lice on the body
  - The second application is to kill the newly hatched larvae

c) Ticks

- Ticks feed on blood obtained from the host animal
- They are the major problem in cattle
- They transmit East Coast Fever, black quarter, anaplasmosis and red water

Fig.: Excel Book 4 pp56. A tick

The life cycle of hard ticks

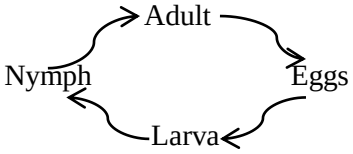


Fig.13.7

- Eggs are laid in the ground which are hatched into larva

Categories of hard ticks

(a) One-host ticks

- They need only one host to complete their life cycle, e.g., the blue tick (*Boophilus decoloratus*) and the cattle tick (*Boophilus microplus*)

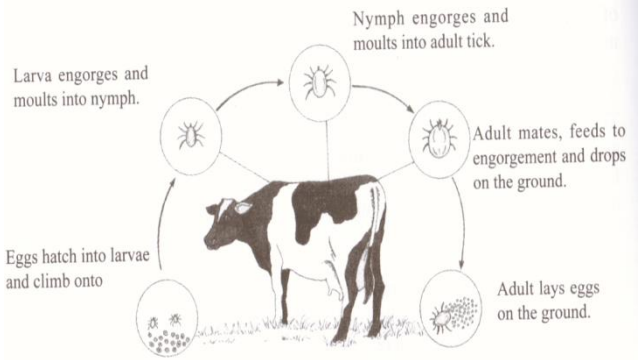


Fig.13.8

(b) Two-host ticks

- These are ticks which need two hosts to complete their life cycle
- Their first moulting stage from larvae to nymph is spent on one host, but the second moulting stage from nymph to adult is done on the second host
- Examples include the red-legged (*Rhipicephalus evertsi*) and the brown tick (*Rhipicephalus bursa*)

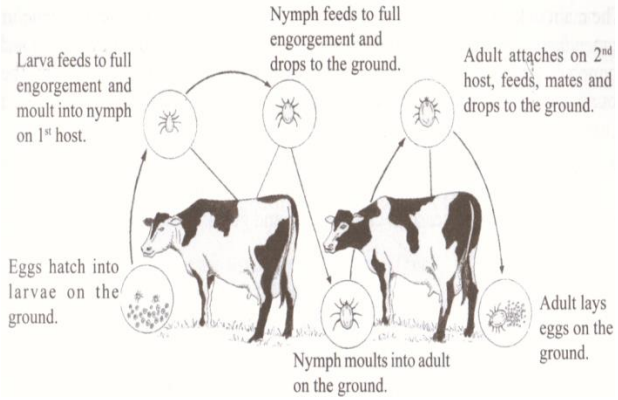


Fig.13.6

(c) Three-host ticks

- These ticks need three hosts in order to complete their life cycles
- Most hard ticks belong to this category

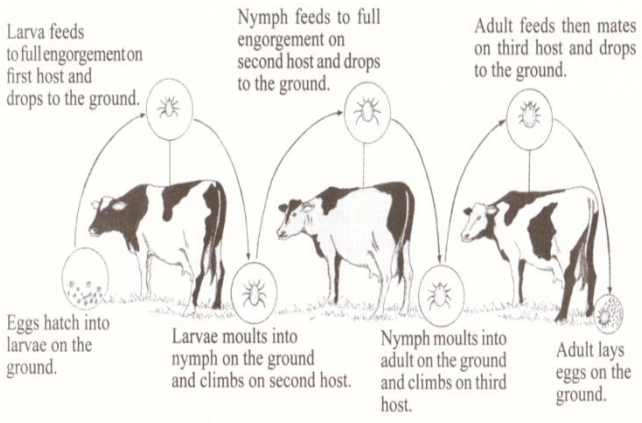


Fig.13.10

Control measures

- Chemical dipping or spraying the cattle regularly to kill ticks
- Fencing to restrict movement of animals thus minimizing spread of ticks

- Rotational grazing
- Burning the infected pasture
- Ploughing the land

d) Tsetse flies

- Tsetse flies (*Glossina spp*) transmit trypanosomiasis (nagana) or sleeping sickness and mastitis
- It leads to stunted growth and loss in yields

Fig.13.9

Control measures

- Clearing bushes to control tsetse flies
- Spraying bushes with insecticides to kill the flies or keep them away
- Sterilization of the male tsetse flies by using chemicals
- Trapping of tsetse flies using special nets treated with appropriate chemicals
- Creating buffer zones near Game Reserves thereby preventing the transmission of infection from wild animals to livestock

(ii) Endo-parasites

❖ These are internal parasites

a) Round worms (*Ascaris spp*)

- Their bodies are long, cylindrical and smooth
- They cause stunted growth in animals, reduction in yields, diarrhoea, constipation and anaemia

Signs and symptoms of roundworm attack

- Retarded growth
- Scours
- Anaemia
- Pot belly appearance

Control measures

- Avoid grazing animals on muddy grounds
- Grazing livestock on well drained pasture
- Practicing rotational grazing
- Isolating and treating animals that are suspected to be infected with roundworms

b) Flukes

- They are shorter than tapeworms and their bodies are not segmented
- Different fluke species live in different areas in the body of an animal
- Flukes are named based on the areas they are found, i.e.,
  - ***Liver flukes*** are found in the ***live***r whereas ***rumen flukes*** are found in the ***rumen*** of the animal
- They cause severe diseases in the areas that are affected
- They often lead to death of the animal

Parts of a liver fluke (*Fasciola spp*)

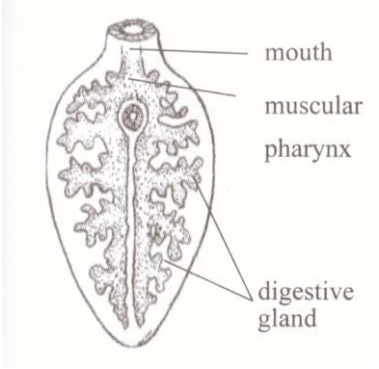


Fig.13.10a

Life cycle of liver flukes

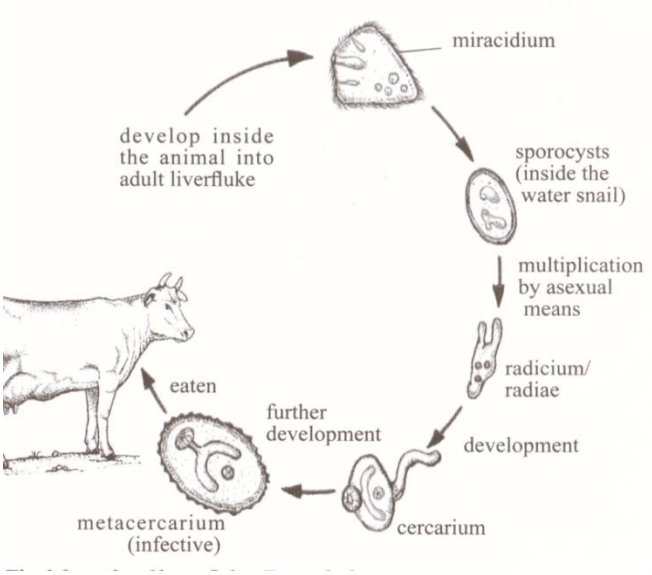


Fig.13.10b

Signs/symptoms of liver fluke attack

- Digestive upsets due to blocking of the bile duct
- Swollen abdomen
- Emaciation and in extreme cases, recumbency leading to death
- Anaemia occurs as a result of destruction of the liver tissues
- Oedema in the jaws (swollen lower jaws)

Control measures

- Practicing controlled grazing
- Keeping cattle away from stagnant water
- Spraying stagnant water with copper sulphate to eradicate mud snails
- Routine drenching by use of appropriate drugs , e.g., antihelminthic drugs
- Fencing off heavily infested swampy areas to prevent livestock from grazing in such infested areas

c) Tapeworms (*Taenia spp*)

- Tapeworms affect all livestock
- They are found in the intestines
- They attach themselves with their hooks to the wall of the small intestines where they develop
- They obtain nutrients directly from the food eaten by an animal

Life cycle of a beef tape worm

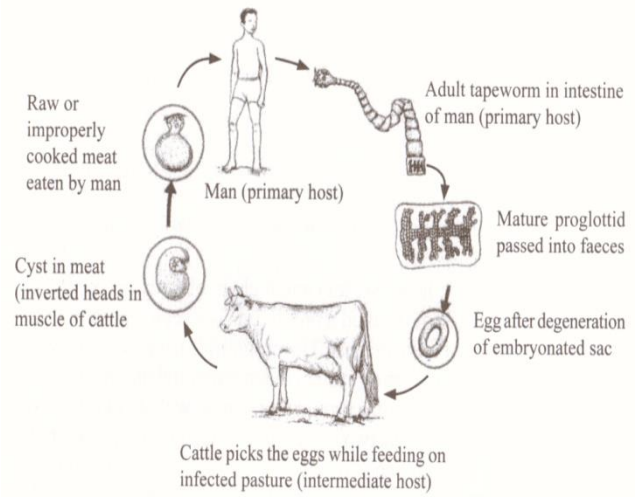


Fig.13.11

Signs/symptoms of tapeworm attack

- Rough hair coat
- Digestive disturbances such as diarrhoea and occasional constipation
- Pot belly
- Anaemia (lack of blood)
- Oedema
- Egg segments or proglottids in the feaces

Control measures

- Ensuring that all beef is properly cooked before eating
- Human feaces should be disposed in appropriate places
- Treating affected animals with copper sulphate after every 6 weeks
- Plough the pasture to kill the cysts
- Proper meat inspection

Diseases cattle

1. Mastitis

- It affects dairy cattle
- It is an infectious disease of the mammary glands
- It is caused by bacteria

Pre disposing factors

- Injury to the udders or teats
- Poor milking hygiene
- Teat sores
- Incomplete milking
  - ✓ Milk left in the teat canal acts as a culture media for bacterial growth
- Level of milk production
  - ✓ High milk producers are much more prone to mastitis than low milk producers
- Age of the cow
  - ✓ Old cows are more prone to the disease than young ones
- Genetic factors
  - ✓ Some breeds are more susceptible to mastitis than others
- Pendulous udders
  - ✓ They are liable to injuries which facilitate mastitis infection

Signs/symptoms

- Blood clots or pus in milk
- Pain in the udder or teats during milking
- Swollen or inflamed udder
- Rise in the body temperature
- Clots in milk or appearing as a clear liquid
- Drop in milk yield
- Blocked teat canal
- Rapid and weak pulse

Control/treatment measures

- Practise farm hygiene, milk the infected cows last, use single clean towel for each cow to wipe the udder or use disposable towels
- Immediate treatment of infected cows to avoid the spread of the disease
- Test for mastitis before milking to avoid spread of the disease
- Apply milking jelly or milking salve after milking
  - ✓ To prevent drying and cracking of teats
- Use teat dip on each teat after milking
- Use good milking techniques
- Infuse long acting antibiotics into the teat canals during drying off period
- Cull those animals which do not respond to treatment
- Vaccinate the animals against mastitis once in a year
- Administer anti-mastitis drugs or antibiotics, e.g., Tetracycline, Streptomycin or Penicillin
- Give corticosteroids if udder is inflammed

2. Milk fever/Parturient paresis

- It affects dairy cows
- It is as a result of *hypocalcaemia*
- Hypocalcaemia is a condition of low calcium level in the blood
- It is more common in heavy milking cows and those cows extremely fed on feeds rich in proteins but low in calcium
- It is common in animals aged 5-9 years
- Breeds mostly affected are Jersey, Guernsey and their crosses

Signs/symptoms

- Muscular twitching causing the animal to tremble
- Staggering as the animal moves
- Inability to stand
- Dull and staring eyes with dilated pupils
- Extremities of feel cold to touch
- The animal lies on the sternum with its neck twisted on one side (sternal recumbency)
- Breathing becomes slow and weak
- The body temperature falls
- General paralysis

Control/treatment measures

- Feed animals on a diet rich in calcium especially during pregnancy and early lactating periods
- Give intramuscular injection of calcium 2-3 days before calving
- Cows with past cases of milk fever should be partially milked for the first 10 days
- Cull susceptible animals
- Injection of calcium borogluconate solution intraveniously, calfojet or calcijet intramuscularly
- Pump air into the udder to limit milk synthesis

3. Bloat/Tympanites

- It is a condition in which gases accumulate in the rumen due to rapid fermentation of the feed eaten by the animal
- The rumen becomes so distended that it compresses the lungs and other internal organs
- It may result in death
- It is caused by:
  - (i) Feeding animals with large amounts of legume and lush forage
  - (ii) Abrupt change in feeds given to animals
  - (iii) Blockage of oesophagus by large food particles
  - (iv) Injury to the nerve supply of the rumen causing paralysis of the rumen

Signs/symptoms

- Distension of the left side of the abdomen due to gas or froth accumulation which can be felt by pressing with hand
- Difficulty in breathing
- Profuse salivation
- The animal lies down and is unable to rise up
- Grunting and kicking at the belly
- Death occurs within hours due to pressure on blood vessels, heart and lungs

Control/treatment measures

- Provide dry roughages just before feeding the animal on green and succulent or wet pasture
- Feed livestock on wilted grasses and pasture legumes
- Exercise the sick animal by walking it around
- Use medical oils as defrothing agents, e.g., liquid paraffin or turpentine mixed with vegetable oil
- Epsom salt can be used to empty the stomach since it acts as a laxative
- A stomach pump can be used to remove the gas
- In extreme cases, trocar and canula or sharp sterilized knife is used to pierce through the skin of the rumen so that gases escape
- Methyl silicone injected directly into the rumen to prevent frothing

4. ***Foot-and-Mouth disease (FMD)***
   - It is caused by viruses
   - It is highly contagious and spreads quickly if not controlled
   - It is a severe disease in cattle

Signs and symptoms

- Animals have a high fever which lasts for a few hours and look dull
- Loss of appetite in cattle
- Profuse and continuous salivation and saliva is sticky
- Swaying of the animal due to tenderness and weakness in the legs
- In some cases, cattle may be lame
- The animals become emaciated and produce less milk
- There are blisters and wounds on the tongue, mouth, gums, toes, burst, teats and nose of the infected cattle
- Kicking of feet

Control/treatment measures

- Imposition of quarantine in cases of outbreaks
- Vaccinate the animals every six months
- Disinfecting the animals' hooves
- Slaughter, burn and bury infected animals
- Nurse the animal by giving it antibiotics, multivitamins, fluids and electrolytes

5. ***Anaplasmosis/Gall sickness***
   - It is a vector-borne disease
   - It is known as the disease of the blood
   - It is commonly transmitted by ticks and livestock equipment, e.g., contaminated needles, dehorning equipment and castration tools

Signs and symptoms

- Cattle have high fever
- They suffer from constipation which leads to loss of appetite
- Animal develops constipation or releases hard dung
- Fast breathing and fast heart beat
- No rumen movement (no chewing the cud)
- The animal produces yellow urine
- Animals suffer from anaemia and the mucous membranes become yellowish
- A drastic loss in weight in the affected cattle
- Most of the cattle have uncoordinated movement
- In extreme cases, the animals usually die

Control measures

- Burning carcasses of dead animals
- Controlling ticks and ensuring that cattle are kept in a clean environment
- Controlling biting insects
- Using clean surgical instruments when carrying out operations such as castration
- Vaccination to control spread of the disease

6. ***Red water/Bovine babesiosis/Tick fever***
   - It is caused by bacteria
   - It is spread by ticks

Signs and symptoms

- Cattle have high fever
- Urine excreted is dark or red in colour
- They have uncoordinated movement
- Animals have swollen lymph glands

Control measures

- Dipping and spraying cattle with appropriate chemicals to control ticks
- Vaccination

7. **East Coast Fever (ECF)**
   - This is a protozoan disease
   - It is transmitted by ticks

Signs and symptoms

- Infected ticks experience difficulty in breathing
- The eyes and gums discolour and become white
- Cattle have enlarged lymph nodes in the areas where ticks are
- Cattle die since their blood capillaries are blocked
- Cattle diarrhoea and the stool has blood stains

Control measures/treatment

- Spraying and dipping cattle
- Carcasses of dead cattle should be disposed of well
- Fencing the farm to keep away stray animals
- Use appropriate drugs, e.g., Butalex and Clexon

8. Trypanosomiasis/Nagana

- It is caused by protozoa
- It is transmitted by tsetse flies

Signs and symptoms

- Intermittent fever in affected animals
- Dullness and loss of appetite
- Cattle become anaemic
- Animals may be seen licking soil and have swollen lymph nodes
- Running eyes or they may become totally blind
- Staring coat
- The animal is exhausted and very weak
- Loss of hair at tail switch
- Belly region becomes swollen
- Fast breathing

Control/treatment measures

- Administering drugs to cattle, e.g., Novidium, Berenil, Evidium
- Confinement of game animals in game parks
- Clearing bushes to control tsetse flies or they may be sprayed using insecticides
- Breeding trypano-resistant animals

9. Foot rot

- It is rampant during the wet season
- It is caused by bacteria
- The bacteria enter the foot of the cattle through wounds on the foot
  - ✓ Cow dung and manure cause the skin to become soft and broken into easily by stones or other objects

Signs and symptoms

- The hooves become swollen
- Lameness may occur in one foot
- A moderate rise in temperature in the animals
- Puss may form in the affected area

Control measures

- Infected cattle should be treated using antibiotics
- Rotten parts of the hooves should be trimmed and removed
- Isolating the affected animals
- Cattle should be provided with a foot bath of copper sulphate solution to prevent the disease
- Routine trimming should be done on the cattle

10. Pneumonia/Bovine respiratory disease

- It is a disease of lungs that attacks calves mostly
- It is caused by different viruses and bacteria

Signs and symptoms

- There is decreased growth rate in calves
- Calves may have either very high or very low body temperature
- Difficulty in breathing is experienced
- The calves may have coughs
- Nasal discharge and congestion in the chest
- There is less movement in the animal
  - ➢ It is usually dull and sleepy
- Loss of appetite

Control measures

- Providing each calf with enough space to avoid overcrowding
- Provide good housing to reduce respiratory diseases
- Proper management practices should be put in place
- Calves should be vaccinated against the disease
- Isolating the affected calves from the healthy ones to reduce the spread of the disease

11. Black quarter/Blackleg

- It is caused by bacteria
- It is difficult to treat because it is severe
- It causes inflammation of the skeletal muscles of cattle
- The bacteria grow and produce large amounts of gases in the muscles of the cattle

Signs and symptoms

- The animal develops a high fever and shivers
- Gas filled swellings of heavy muscles of neck and legs
- Grunting and grinding of teeth
- Loss of appetite and dullness
- The limb swells and when pressed, it produces a cracking sound
- Lameness may develop in the affected leg
- The skin over the swelling is not sensitive to touch
- Death within 12-48hours
- Black meat which has a sweet smell in the hind legs
- Animal stops chewing cud
- There is blood stained exudate from the anus and those with characteristics of smell of rancid butter

Control measure

- Vaccinate cattle against the disease regularly
- If detected early, the animals should be treated with antibiotics
- Livestock quarantine
- Burying the carcasses of the infected animals deep into the ground

12. Tuberculosis

- It affects the lungs but may spread to other tissues
- It is caused by bacteria *Mycobacterium bovis*
- It is transmitted through inhalation of droplets containing the bacteria in adult cattle
- It can also be taken with contaminated milk in young calves

Signs/symptoms

- Respiratory problems
- Coughing
- Swellings of lymph nodes at the junction of the neck and head around the throat
- The animal appears dull and loses appetite

Control

- Carry out quarantine measures
- Slaughter and properly dispose of the affected stock

13. Rinderpest

- It is highly infectious and contagious
- It is classified as a notifiable disease
- It is caused by virus known as *Paramyxo virus*

Signs/symptoms

- Rapid rise in body temperature
- Mucous membranes of the mouth and nose become red-hot and painful
- Dry and cracked muzzle
- Smelly ulcers develop in the mouth and nose
- Labored breathing and persistent cough
- Profuse diarrhoea
- Eye and nose discharge
- Animals grind their teeth
- Staring coat
- Death in 2-10 days

Control/treatment measures

- Imposition of quarantine in case of the outbreak
- Vaccination of all animals that are more than one year old
- Kill all the infected animals and dispose of their carcasses properly
- Disinfect the animal houses
- Isolate the sick animals
- Give the animal antibiotics, fluids and electrolytes

14. Lumpy skin disease

- It is an acute infectious disease of cattle of all ages
- It is caused by lymph skin disease virus
- It is transmitted through bites of mosquitoes and flies

Signs/symptoms

- Fever
- Emaciation
- Milk production cease
- Low mortality

Control/treatment measures

- Vaccination
- Quarantine
- Vector control
- Animals generally recover with good nursing care
- Antibiotics for secondary infections are administered

15. Brucellosis/Contagious abortion

- It is caused by a bacterium known as *Brucella abortus*
- It causes abortion and premature calving

✓ Between fifth and eighth month of pregnancy

- It is normally spread through vaginal discharges of an infected cow or from a foetus that has been aborted
- Infected bulls can infect cows when the cows are served using the infected semen

Signs and symptoms

- The vulva becomes swollen and inflamed
- There is slight discharge from the vulva
- An increase in the blood-stained discharge from the vulva
- A yellowish brown discharge can be seen from the vagina after abortion or normal delivery

Control measures

- Vaccination of cattle and calves
- Quarantine infected cattle to prevent the spread of the disease
- The uterus can be washed with antiseptic solutions

16. Anthrax

- It is highly infectious
- It attacks both cattle and human beings
- It is very fatal
- It is caused by a bacterium known as *Bacillus anthracis*

Signs and symptoms

- Sudden death occurs in cattle
- The cattle become weak and have high fever
- The animals become excited at first and then become depressed
- There is difficulty in breathing
- Uncoordinated movement in animals
- Blood is discharged from the natural body openings, e.g., nose and ears
- Dead cattle decompose very

Control measures

- Treat the animals early with antibiotics
- Vaccinate cattle against the disease
- Bury the carcasses of dead cattle deep in the ground

General methods of controlling parasites and diseases

(a) Vaccination
(b) Deworming
(c) Dipping using a ***plunge dip***
(d) Spraying
✓ Hand spraying
✓ Using a spray race

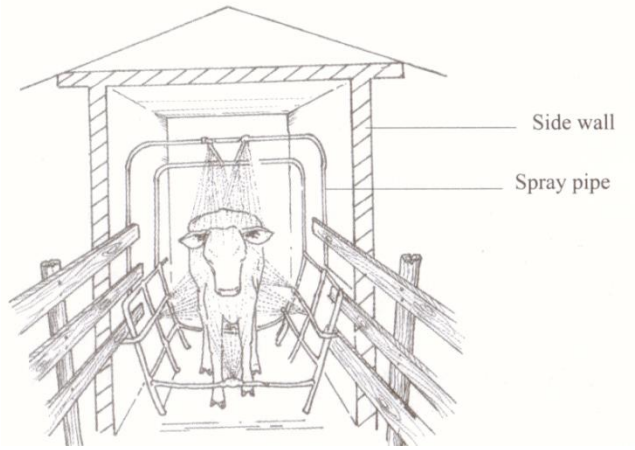


Fig.13.12a

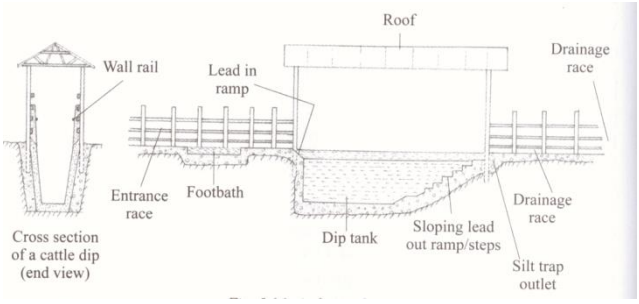


Fig.13.12b

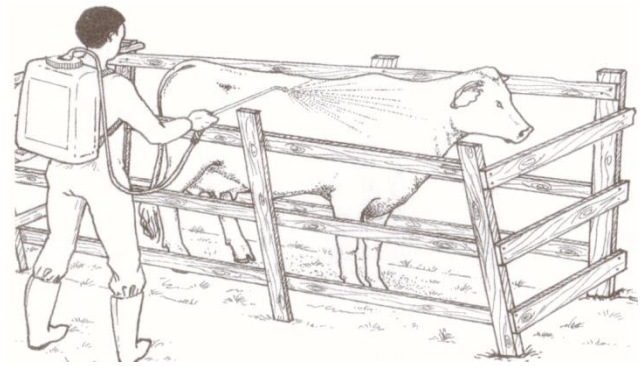


Fig.13.12b

TOPIC 14: REPRODUCTIVE SYSTEMS OF CATTLE AND POULTRY

Reproductive system of cattle

- The reproductive system produces the male gametes whereas the female produces female gametes
- The male gametes are known as spermatozoa whereas the female gametes are known as the ova
- Fertilization takes place when the male and female gametes fuse to form a zygote.

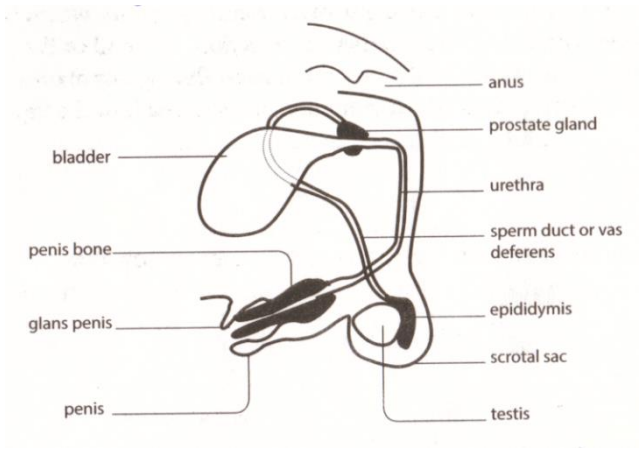


Fig. 14.1

Functions of parts of a bull

Part	Functions
Testicles (testes)	• They produce spermatozoa • They produce testosterone
Epididymis (long coiled tube in testes)	• It transports the sperm cells from the testicles to the vas deferens • It helps in the maturation of the developing spermatozoa • It sores the sperm cells in its tail
Vas deferens (sperm duct)	• It further transports spermatozoa through contraction of smooth muscle tissues that surround it during ejaculation
Urethra (channel passing through penis)	• It acts as a common passage for urine from the urinary tract, and semen from the reproductive tract
Accessory glands (seminal vesicles, prostate and Cowper's gland)	• Secrete secretions that nourish the spermatozoa and lubricate the urethra • They also neutralize the toxic conditions of the urine for easy passage of the spermatozoa
Penis (organ of insemination)	• It deposits semen which contains spermatozoa into the vagina of a cow

Female reproductive system of a cow

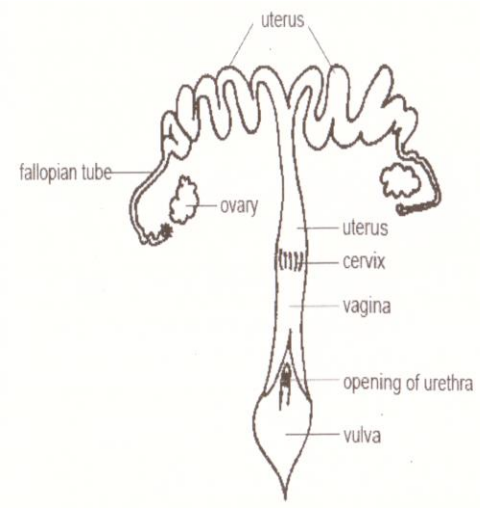


Fig.14.2

Functions of the parts of the female reproductive system of a cow

Part	Functions
Vulva (external part of the reproductive system)	• It is the passage of urine • It is used for mating • It is part of the birth canal
Vagina (part that extends from the opening of the urethra to the cervix)	• It serves as part of the birth canal • It is where semen is deposited during mating
Cervix (a thick walled part between vagina and uterus)	• It connects the vagina and the uterus • It protects the uterus from the external environment
Uterus	• It is where semen is deposited during artificial insemination • It is where the foetus develops • It secretes fluids as uterine

	milk that provides the nutrients for the developing embryo • It develops the placenta which protects the foetus
Oviduct/fallopian tube	• T is used to carry the ovum or as a passage for ovum • It is where fertilization takes place • Its infundibulum
Ovary (a cow has two ovaries)	• They release the egg or ovum

Puberty in cattle

- Exotic breeds of cattle attain puberty at the age of 15-19 months
- Indigenous breeds of cattle reach puberty at 27-30 months
- ❖ Variations also depend on management practices, especially feeding

Factors that affect onset of puberty

- Type and breed of animal
  - ➢ some animals mature more quickly than others, e.g., exotic breeds
- Genetic make-up
  - ➢ Dairy cattle breeds tend to reach puberty much earlier than beef cattle breeds
- Body weight
  - ➢ Most animals reach puberty when they have attained at least 30-50% of adult weight
- Mating
  - ➢ It may hasten puberty, e.g., in rabbits
- Environmental factors
  - ➢ Puberty may be delayed due to unfavourable climatic conditions, e.g., during drought, feed and water become scarce
- General management, especially feeding
  - ➢ Calves that are properly fed and well looked after tend to reach puberty earlier than those that are poorly managed

Oestrus cycle in cows

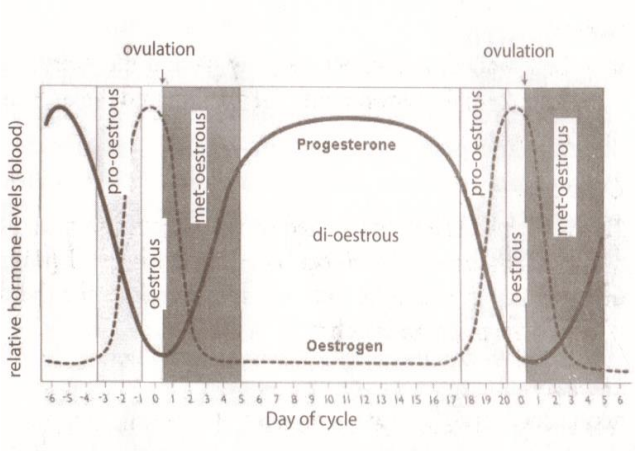


Fig.14.3

- ❖ Oestrus is heat period for an animal.
- ❖ The oestrus cycle is the period between one heat period and the next.
  - ✓ In cattle, heat period is at average 21 days
- Egg development is stimulated by a hormone known as ***oestrogen***
- The egg takes six hours in the oviduct before disintegrating
- As soon as the egg is released, the level of oestrogen drops sharply and the level of progesterone rises sharply
  - ✓ Progesterone prepares the uterus to receive the embryo
  - ✓ It also maintains pregnancy if the egg is fertilized
- The sperms can stay in the reproductive tract of a cow for 20 to 30 hours

Oestrus cycle and ovulation periods

Animal	**Length of oestrus cycle (14days)**	**Duration of oestrus cycle (hours)**	**Ovulation period (hours)**
Cow	19-23	10-26	4-6 hours after onset of oestrus

Phases of the oestrus cycle

1. ***Pro-oestrus (day 17-20)***
   - It marks the animal's coming in heat
   - The follicles within the ovary are growing due to an increase in the secretion of follicular fluid
   - Follicular fluid surrounds the ovum and contains the hormone oestradiol
     - ✓ It causes the growth of the cells lining the oviduct

- ✓ It increases the number of cilia which shortly transport the ova to the uterus
- The epithelial wall of the vagina increases in thickness
- The vaginal adjustment is well fitted to prevent possible damage to the wall when coitus occur
- ❖ Coitus is the physical union of the male and female genitalia

2. ***Oestrous (Day one of new cycle begins)***
   - This is the period of desire for mating
   - The follicle are now swollen and the ovum is undergoing certain maturation stages
   - The period is closed by ovulation
   - ❖ Ovulation is the process of rupturing of the follicle
   - Heat period for a cow lasts for 12 to 24 hours
   - The vulva becomes swollen
   - The vulva and vagina are congested with blood

3. ***Met-oestrous (2- 4days)***
   - It is a period when the organ returns to normal size
   - The cavity of the follicle reorganizes and forms corpus luteum which secretes progesterone
   - ❖ Corpus luteum is a gland which secretes the hormone progesterone
   - Progesterone prevents further maturation of the follicles and thus prevents occurrence of oestrous period

4. ***Di-oestrous (day 5-17)***
   - It is the longest phase
   - The corpus luteum is fully developed
   - The muscles of the uterus also develop
   - If pregnancy occurs, this stage is prolonged through gestation
   - In absence of fertilization,
     - ✓ the corpus luteum undergoes some changes
     - ✓ the ovum becomes vacuolated and loaded with large lipid droplets
     - ✓ there follows rapid re-absorption of the corpus luteum

Signs of heat in cattle

- the cow will smell other cows and attempt to mount them
- the cow then become restless ad isolates itself from other cows
- its vulva becomes moist, red and slightly swollen
- the cow stands still to be mounted or when other animals try to mount it
  - ➢ this is called standing heat
- The animal loses appetite
- It urinates frequently
- There is a slight rise in body temperature
- The animal starts bellowing a lot
- The milk yield decline sharply in lactating cows
- There is a clear mucus discharge from the vulva

Time for breeding a cow

Standing heat first observed	**When to breed**
In the morning	Late afternoon the same day
In the afternoon	The next morning

Gestation period for some animals

Animal	**Gestation period**
Cattle (cow)	270-285 days
Goat (nanny)	150 days
Sheep (ewe)	145-150 days
Pig (sow)	112-116 days
Rabbit	28-31 days

Processes of reproduction in cattle

1. ***Mating***
   - ❖ Mating is the process of copulation of male gametes and female gametes
     - ✓ This is done naturally or through artificial insemination (AI)

(a) Natural mating

- This is when a male animal directly mounts on a female animal

Advantages

- The male animal can tell when the female is on heat and ready to be served
- It is cheap as a no skilled personnel or expensive equipment is needed to collect and store semen
- It induces puberty and oestrus in some female animals

Disadvantages

- It may lead to inbreeding
- Undesirable traits are passed on through flock mating
- Venereal diseases are easily passed on from one animal to another

(b) Artificial insemination

- This is the process of injecting the semen of a male animal into the female reproductive tract

Advantages

- It helps to improve the herd through collection of semen from good quality breeds
- It helps to control inbreeding
- It is cheaper for a smallholder farmer to acquire artificial insemination service than buying and keeping a bull for a small herd or flock of animals
- Sexually transmitted diseases can be checked
- Semen from a desirable bull can be stored and used long after the death of the bull

Disadvantages

- Administration of artificial insemination requires skilled or trained personnel
- It may fail if oestrus or heat period is not properly detected
- Artificial insemination services may not be readily available in remote areas
- Collecting and storing semen is not easy and requires special equipment

2. Fertilization

- Fertilization takes place when viable sperms are deposited in the reproductive system of a cow after ovulation has occurred
  - ✓ Fertilization results into the formation of a zygote (one-cell embryo)

3. Embryo development

- Embryo development refers to the early period of development in which no distinct structure has formed
  - ✓ It takes place in the uterus

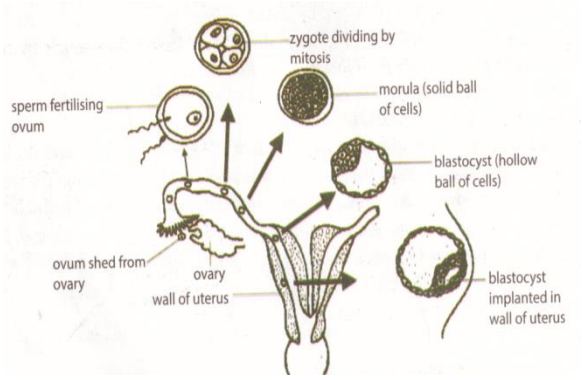


Fig.14.4

- The embryo undergoes differentiation
- The cells (morula) start functioning as specialized structures
- ***Morula*** refers to the group of cells formed through cell differentiation

4. Foetus development

- It is an advanced stage after embryo
- Foetus grows in the uterus
- It is nourished through the umbilical cord that is attached to the walls of the uterus through the placenta
  - ✓ The umbilical cord also acts as a passage of waste from the foetus to the blood stream of the cow
- It is cushioned in the amniotic fluid
  - ✓ It protects the foetus from external shock
  - ✓ It maintains suitable temperature around the foetus

5. Parturition (birth)

- This is the process of giving birth
  - The corpus luteum reduces the production of progesterone hormone and increases the production of oestrogen hormone
    - ➢ High levels of oestrogen cause the uterus to begin contracting

Signs of parturition in a cow

- The cow becomes restless and nervous
- The udder enlarges and is filled with milk just before calving
- The muscles on either side of the pin bones widen
- The vulva swells and enlarges
- Mucus discharge comes out from the vulva
- The cow isolates itself from others
- The water bag appears followed by labour

Signs of complications during the process of parturition

- A long delay in the appearance of the calf once the water bag breaking
- If calving is taking more than 3 hours after some parts of the calf appear
- In case of breech presentation (rear parts trying to come out first)
- If the cow is in distress such that there is no sign of water bag after many hours of straining
- Only one limb appearing after the water bag has burst
- Discharge of smelly fluid indicating death of the calf

Normal parturition

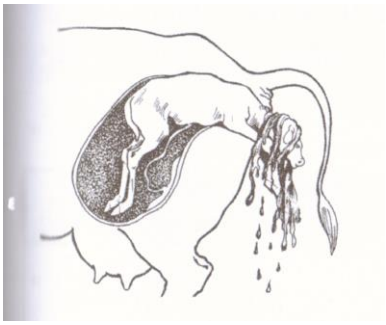


Fig.14.5

Types of calving implications

Implication	**Solution**
When one or both fore legs are bent forwards as the head protrudes	Pushing the head back inside so as to allow the legs to be pulled out with head resting on the legs
If the head is twisted backwards to either side	Pulling the head around and position it on top of the legs
Breech presentation of the calf	Turning the calf around completely within the womb
When the whole reproductive tract is twisted	It is a very complicated condition that requires an expert for it to be sought

❖ **Breech presentation** is the situation where the rear of the calf comes out first instead of the fore legs

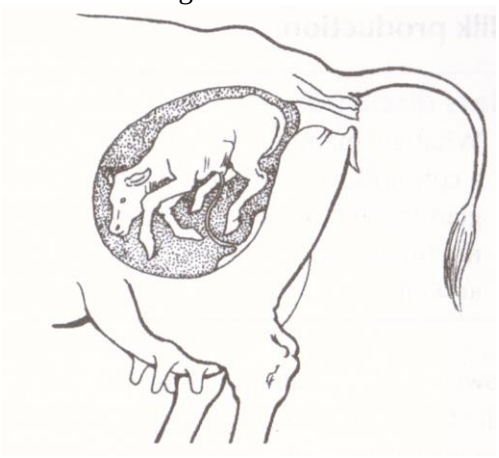


Fig.14.6

Factors to consider when providing help to a cow during parturition

(a) Wash hands and arms with warm soapy water mixed with antiseptic
   - Clean and disinfect materials for use or use sterilized equipment
   - If cow vulva has dried out, lubricate it with clean ,warm soapy water

(b) Restrain the cow and check if the calf is oriented in its normal position

(c) Provide the help immediately

(d) If hands or ropes were inserted into the cow during the time of assistance, treat the animal with antibiotic tablets to avoid later infections

NOTE:

- The correct presentation of the calf should be that the front feet come out first followed by the head which should be resting on the feet
- When labour lasts for more than 2-3 hours, there is a possibility of mal-presentation
- The release of the after birth is the last stage in parturition
- The after birth consists of the placenta
- The placenta must be removed from the uterus of the cow if it has remained behind to avoid barrenness of the cow

Reproductive system of poultry

Parts of a chicken

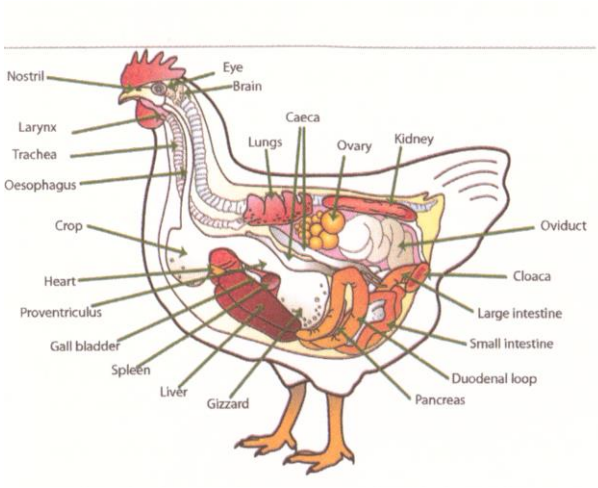


Fig.14.7

Female reproductive system of poultry

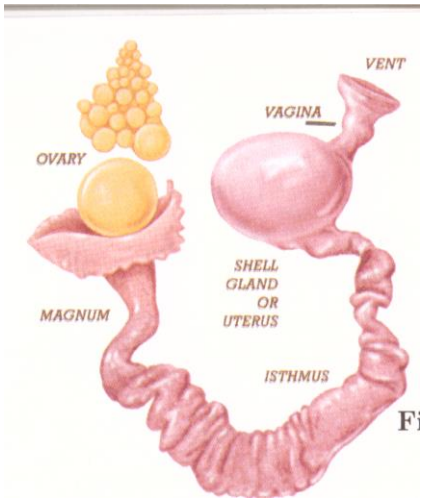


Fig.14.8a

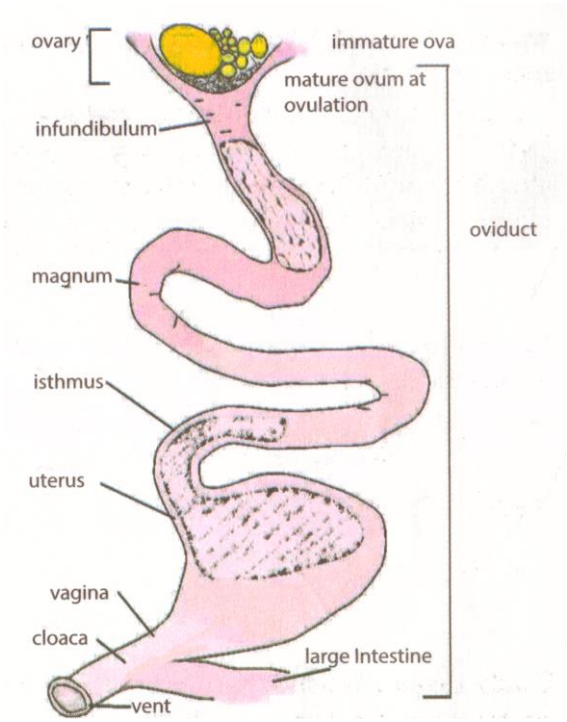


Fig.14.8b

Functions of parts of the female reproductive system of poultry

Part	**Functions**
Ovary	• It releases the ovum to the infundibulum
Infundibulum	• It is where fertilization of eggs takes place • It is where sperms are stored after mating with the cock
Magnum	• It secretes albumen, which is added to the yolk
Isthmus	• It is where the inner and outer egg membranes are formed to represent the final shape of the egg including an air cell or air sac between them
Uterus or shell gland	• It adds water and salts to the egg through the membranes by osmosis • It is where the egg shell is formed through deposition of calcium carbonate ($CaCO_3$)
Vagina	• It serves as a passage for the egg • It adds the shell pigment
Cloaca	• It serves as a passage for the egg (oviposition)

Male reproductive system of poultry

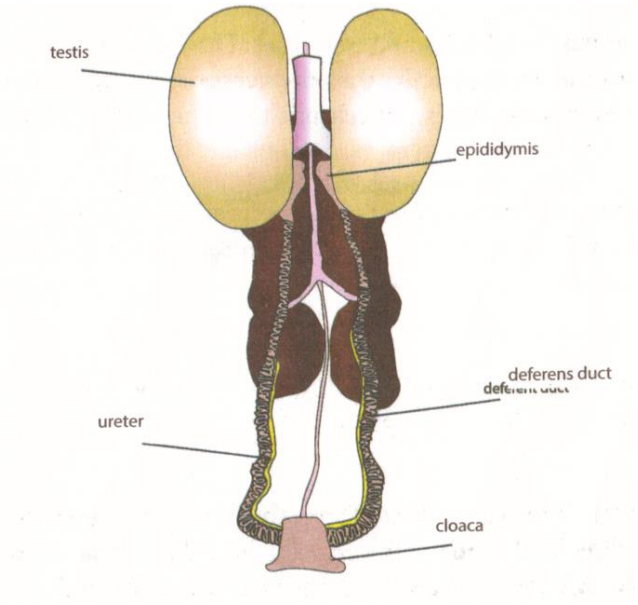


Fig.14.9

Functions of the parts of the male reproductive system of poultry

Part	Function
Testis	Produce sperms
Vas deferens	They lead sperms to the cloaca
Cloaca	▪ Project to the vent opening (papillae) ▪ During mating it fits into the protruded cloaca of the hen and releases sperms

TOPIC 15: LIVESTOCK IMPROVEMENT

- ❖ Livestock improvement is a programme that sets out to improve the inheritance of the animals and their management so as to realize high production.
  - It is done through

(i) Breeding
(ii) Proper management

Aims of livestock improvement

1. To obtain high quality of animal products, e.g., milk, meat and wool
2. To increase livestock production potential
3. To increase disease resistance of the animals
4. To increase the animals' tolerance to high ambient temperatures and other adverse environmental conditions
5. To encourage self-employment
6. To improve indigenous livestock breeds

Methods of livestock improvement

a) Selection

- ❖ This is the practice of making deliberate decision to allow some animals to be the parents of the next generation
- ❖ It is based on the desired characteristics

Aims of selection

(i) To change the frequency with which certain genes occur in a population of animals
(ii) To increase the value of farm animals and increase productivity
(iii) To increase the frequency of desirable genes and decrease the frequency of undesirable genes

Methods of selection

(a) Individual or mass selection

- It involves the selection of individuals based on their performance
- Phenotype characteristics are used to choose the best animal
- Observable characteristics used include
  - ✓ Coat colour
  - ✓ Size of the body
  - ✓ Shape of the head

(b) Selection by contemporary comparison

- This is a comparison of animals based on their individual performance
- The best individual is selected from animals of the same age-group that have been similarly treated
- The animals compared should be within the same environment

(c) Selection by progeny testing

- This is the measurement of the genetic value of the animal on the basis of the production records of its offspring
- It depends on progeny testing

(d) Sib-selection

- This is the selection programme based on the phenotypic value (performance) of the offsprings of a particular animal
- Animals whose offsprings are noted to be of superior performance are selected

Factors to consider in progeny testing

- Test as many sire offsprings as possible
  - ✓ The recommended minimum is 5-10
- Make sure that the dummies are randomized to each sire within that age group if possible
- Produce as many offsprings per sire as possible
  - ✓ In cattle, aim for 10-15 of either sex especially if testing for growth traits
- No offspring used should be culled till the end of the test

b) Breeding

❖ Breeding is a method of livestock improvement that aims at improving the yields of livestock products and to increase resistance against diseases and harsh environmental conditions such as cold weather and high temperatures.

Ways of livestock breeding

(i) Selection

- Selection is a process of allowing certain animals to be parents of the future generation
  - ✓ A few animals in the herd are selected and retained for breeding while others are sold out
  - ✓ Selection increases the frequency of the desirable genes and decrease the frequency of undesirable ones

(ii) Mating

➢ It is done after selection

Ways of mating

a. Natural mating

- The male animal naturally mates with the female
- It is very common and occurs in nearly all livestock

Advantages of natural mating

- It is less laborious to the farmer especially when males are kept together with females
- ✓ Males detect the females on heat by themselves
- Conception rate is high
- It is a more suitable method of mating females whose heat periods are difficult to detect

Disadvantages of natural mating

- There is high risk of spreading diseases like brucellosis from one animal to the other
- There are many chances of uncontrolled breeding especially when males and females stay freely together
- A farmer incurs extra expenses by keeping male animals for purpose of breeding only
- Male animals cannot be easily transported for long distances for service
- Large male animals may injure weak or small female animals

b. Artificial insemination

- This is the artificial introduction of semen into the female reproductive tract by using a syringe and a catheter
- A catheter is a thin flexible tool put into the body of an animal to remove or introduce a liquid
  - ➢ Semen is usually collected from proven bulls that have been certified

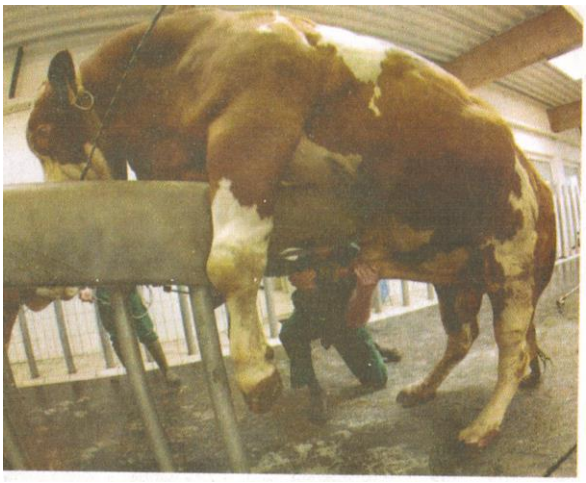


Fig.15.1a: Semen collection using a dummy cow

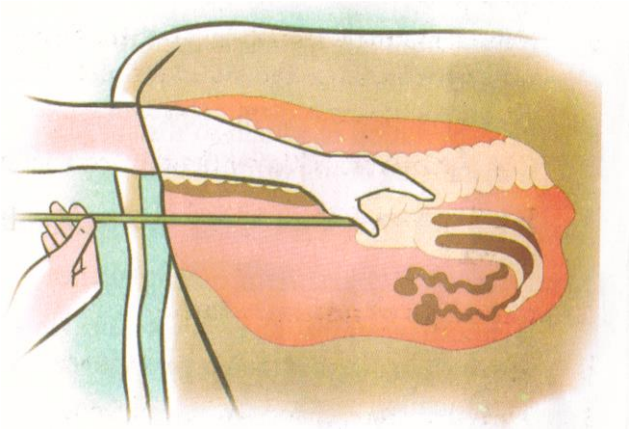


Fig.15.1b: *Rectal-vaginal insemination*

The process of artificial insemination

Artificial insemination starts with semen collection. To collect semen, a cow on heat or dummy cow is placed in the crush for the bull to mount. As the bull mounts it, the semen collector holds the bull's penis and directs it into the artificial vagina. Due to the warmth created by water in the lubricated artificial vagina, the bull will ejaculate.

The semen is then examined for quality using a microscope. It is diluted and stored in a frozen state at very low temperatures, using liquid nitrogen.

Using the recto-vaginal method, the semen is deposited in the cervix of a cow during insemination.

Caution during artificial insemination

- The inseminator should wear well-lubricated gloves before inserting the hand into the anus to feel the cervix from within the rectal wall
- He or she should carefully insert an inseminating tube or catheter through the vagina, pointing upwards to prevent it from entering the urethra

Advantages of artificial insemination

1. Semen from one proven bull can be used to serve more cows than a bull would serve under natural mating
2. Farmers do not incur expenses of buying a bull, feeding it and maintaining it in good health
3. It prevents risks from bulls to the farmer since they are potentially dangerous animals
4. Semen from bulls cannot serve naturally because of certain physiological problems or being overweight can still be used
5. It helps to control the spread of breeding diseases
6. Semen from heavy bulls can be preserved in a frozen state and still be used long after a bull has died
7. Semen from heavy bulls are used to serve small cows or heifers without them being injured
8. Transporting semen to distant places, or importing the semen, is easier than transporting or importing a bull
9. It is much easier for a farmer to control breeding in the farm, and avoids inbreeding.

Disadvantages of artificial insemination

1. It requires more labour
2. It requires the services of trained people who may not be readily available
3. Occasionally, bad genetic characteristics or traits which are not detected in time can be spread to may cows within a short period of time
4. Low rates of conception are common.
5. It is difficult to serve cows or animals with silent heat
6. It is very expensive for the government or a central body that provides the services to farmers

Livestock breeding systems

(i) Cross breeding

- Cross breeding is the mating of pure breed animals of different breeds, e.g., a Friesian bull with an Ayrshire cow
  - The main aim is to introduce new genes into the herd
  - The off springs have hybrid vigour or are heterosis

(ii) Inbreeding

- This is the mating of closely related animals, e.g., a sire is mated to its daughter
  - Pure blood lines are normally produced
  - The main aim of inbreeding is to consolidate certain good characteristics
  - The disadvantage is that the same bad characteristics may also be retained

(iii) Out breeding/out crossing

- ❖ This is mating of unrelated or distantly related animals of the same breed, e.g., mating an Ayrshire cow raised in one farm with an Ayrshire bull from a distant farm
  - ➢ It helps to maintain breed characteristics such as colour

(iv) Line breeding

- ❖ Line breeding is the mating of animals of the same breed which are less closely related, e.g., cousins or grand sires with grand-daughters
- ❖ It is a mild form of inbreeding
  - ➢ It is aimed at conserving or perpetuating some characteristics of the outstanding animals
  - ➢ It is rarely used in commercial production

(v) Upgrading

- ❖ This is the successive use of pure bred bulls of a superior breed to mate cows of an inferior breed in relation to certain characteristics
- ➢ The aim is to upgrade the inferior breed by concentrating the genes of the pure bred bull.

Characteristics of livestock to be selected for breeding

1. ***Fertility***
   - The livestock that are fertile should be used to ensure that off springs are produced to increase the herd of livestock that a farmer has
2. ***Size***
   - Large and well-built animals should be selected so that they transfer these traits to their off springs.
3. ***Growth rate***
   - Livestock that growth quickly are efficient users of food should be selected for breeding
4. ***Conformation***
   - Animals of the right shape and correct proportion in the back and the hind quarters should be selected
5. ***Progeny***
   - Select animals whose previous off spring grew faster

Terms used in breeding

(i) **Chromosomes** are structures that carry genes

(ii) **Genes** are units of inheritance

(iii) **Allele** refers to a pair of alternative forms of a gene which define a characteristic

(iv) **Dominance** means the character has been suppressed or dominated (masked) by another character

(v) **Recessive** refers to the breeding character that suppresses the other

c) Introduction of exotic breeds

- This is the process of importing exotic, pure bred animals from another country.
  - ➢ All exotic animals, e.g., Friesian and Jersey
- They should managed properly to improve the livestock
- It can also be done by importing or harvesting semen from exotic breeds which can be used to mate the local female animals through Artificial Insemination (AI)
- In advanced technology, imported superior embryo are transplanted in the uterus of local female animals, a process called ***embryo transfer***