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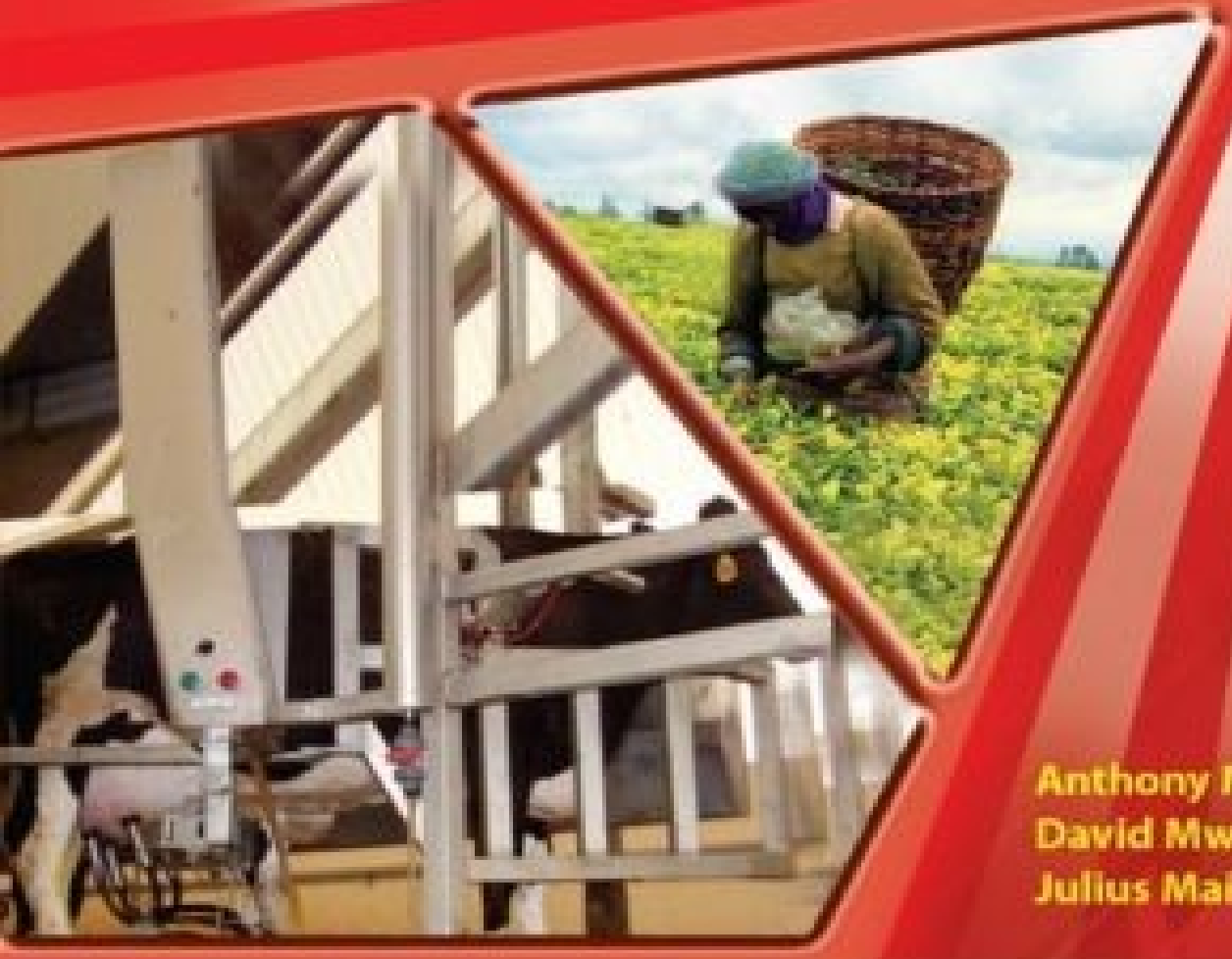
Form 4



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Agriculture and the Environment

Topic 1

Agriculture and the Environment

Unit 1: Soil Degradation and Agriculture

Unit 1 Soil Degradation and Agriculture

Specific objectives

By the end of this unit, you should be able to:

(a) Describe forms of soil degradation.

(b) Explain causes of soil degradation

(c) Describe effects of soil degradation.

(d) Control soil degradation.

Introduction

Soil degradation is a human-induced activity or natural process which leads to a decline in land productivity. Soil erosion is the main factor for soil degradation. In Malawi, it is estimated that soil erosion causes loss of about 20 tonnes of topsoil per hectare per year. This consequently leads to a decline of about 11% of crop yields per year.

Soil erosion is the process of removal and subsequent carrying away of top soil. Soil degradation is classified into:

(a) Slight degradation

This refers to land where yield potential has been reduced by 10%.

(b) Moderate degradation

This refers to land where yield potential has been reduced by 11-50%.

(c) Severe degradation

This refers to where the soils have lost more than 50% of their yield potential.

Agriculture increases the risk of erosion through its disturbance of vegetation by way of:

- Overgrazing of animals.
- Practising monoculture.

• Row planting.
• Tilling/ploughing of land.
• Crop removal.
• Land use conversion.

Forms of soil degradation

1. Water erosion

Water is the main agent of erosion in most parts of Malawi. Running water has high erosive power especially water running under high speed.

There are several types of water erosion.

Fig. 1.1: Splash / raindrop erosion .

(a) Splash erosion/raindrop erosion

This results from the impact of raindrops on the soil surface. As a raindrop falls, it gains kinetic energy. When it hits the soil surface, it detaches and disperses loose soil particles which are easily carried away by surface run-off. This splashing action creates a hole on the land surface. Splash erosion usually marks the beginning of the other types of water erosion.

Fig. 1.2: Sheet erosion .

(b) Sheet erosion/overland flow erosion

This is the uniform removal of soil in thin layers caused by wind or flowing surface water which detaches and transports sheets of topsoil over a wide area. The water flows over the land surface at a relatively low speed carrying away the topsoil. This type of erosion occurs in gently sloping or relatively flat bare land.

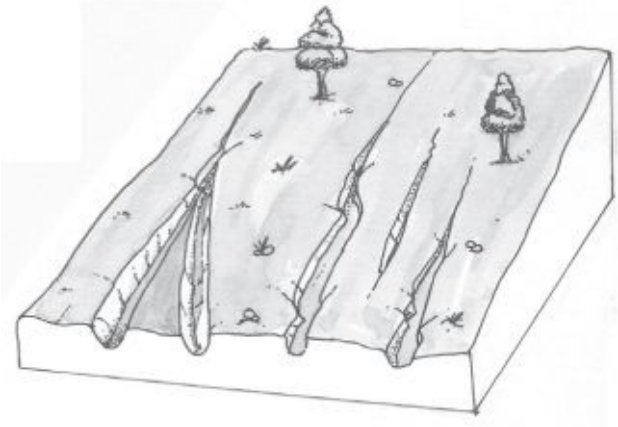


Fig. 1.3: Rill erosion

(c) Rill erosion

This is the removal of soil by running water in small channels (rills) where there is a concentration of flowing water down the slope. This type of erosion is found on slopes with less or no vegetation or where land has been ploughed. A rill can be destroyed by use of farm implements during ploughing.

(d) Gully erosion

This is an advanced stage of rill erosion. The small channels get progressively deeper and wider until they become gullies. The difference between gulley erosion and rill erosion is that the channels in a gulley are so deep and wide such

that they cannot be covered by ordinary ploughing while rills can be destroyed. It is commonly found in steep areas with loose soil and heavy rainfall downpours.

Fig. 1.4: Gulley erosion .

Gully formation

A gulley develops by various processes which may occur at the same time or at different times.

These processes include:

(i) Movement of water from the watershed.

(ii) Erosion of the rills at the sides and bottom.

(iii) Enlargement of rill's width through further erosion.

(iv) Further deepening of the rills as a result of scouring of the channel floor by running water.

Types of gullies

There are V-shaped and U-shaped gullies. V-shaped gullies occur where soils are deep and have unprotected depressions while U-shaped gullies occur where there are materials on the channel floor which resist the scouring.

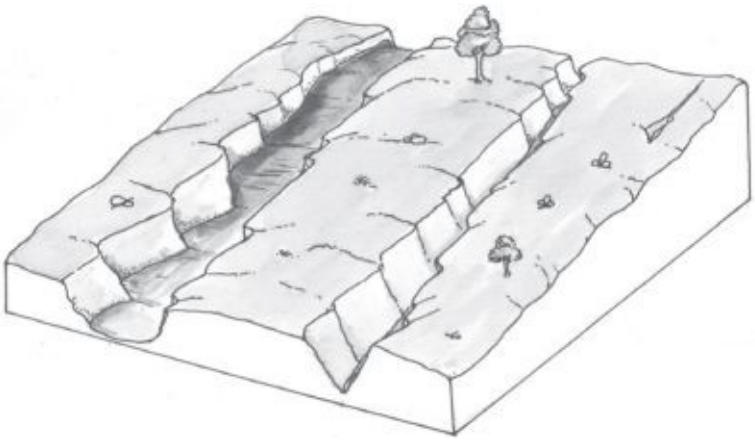


Fig. 1.5: U-shaped and V-shaped gulleys

(e) River bank erosion

This is erosion caused by rushing streams and rivers along their banks. This occurs as a result of scouring of the banks by the flowing water, especially, where the soil is not bound by roots of trees along the water channels. River bank erosion causes river channels to become wider. After detachment of the soil particles, fine clay is transported in suspension while heavier materials settle at the bottom of the river channel.

(f) Solifluction

This is the flow of the soil and weathered rock materials saturated with water by gravitational force down a slope. The speed of movement of the soil material is slow. For example, clay soils saturated with water on a sloppy area may behave as a plastic mass moving as a thick viscous fluid. This type of erosion may be very destructive since it not only reduces soil fertility but also causes damage to property that is, burying of field crops or even loss of life.

(g) Landslides

This is a sudden movement of rock debris and soil down a slope. The materials have very little water in them. This is common on mountain slopes and is very destructive.

Effects of solifluction and landslides

(i) They block river courses causing floods.

(ii) They damage property such as crops, railway lines, roads and may lead to loss of lives.

(iii) They leave the land permanently bare and unable to support vegetation.

(iv) They damage infrastructure by cutting off railways or roads.

(v) They displace fertile soils to other areas.

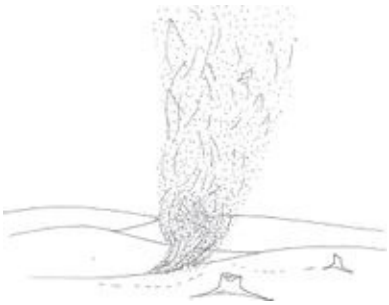


Fig. 1.6: Wind erosion .

2. Wind erosion

Strong wind removes and carries away loose soil particles.

Wind erosion is common in places where soils are dry and loose in arid and semi-arid areas. Wind erosion causes dust storms and is worsened by overgrazing and excessive tilling of land.

3. Chemical degradation

Excessive use of agro-chemicals such as pesticides, herbicides and fertilizers destroy soil structure and affects activities of soil organisms.

Industrial pollutants such as heavy metals change chemical balance of soils.

Salts tend to build up in the soil where there is insufficient rainfall to flush salts from soils. The accumulation of salts in the soil is termed as **soil salinity.** It may also be caused by over-application of irrigation water, poor drainage, inadequate application of water to leach away the salts. Chemical degradation may lead to deterioration of the water quality and loss of biological diversity.

4. Physical degradation

This is the loss of soil particles by erosion, destruction of soil structure, surface sealing and compaction of soils. Soil erosion can occur by wind or water. It is a natural process accelerated by human activity. Water erosion is more widespread in Malawi. It causes loss of productive soil and nutrients. Eroded soil can block water courses and drains, affect fisheries and increase risk of flooding.

5. Biological degradation

Many key soil functions are influenced by biodiversity and organic matter found in it. Organic matter enters soil mainly from plant remains and organic manure additions. Biodiversity and organic matter can decline due to erosion or pollution leading to reduction in soil functions such as drainage and aeration.

Causes of soil degradation

The following are some of the causes of soil degradation:

(i) Clearing and deforestation of large tracts of land leads to change in humus composition and soil formation.

(ii) Tillage destroys the soil structure as well as increases oxidation of humus. It

can also compact lower layers of soil due to regularly passing of same implement through the soil at the same depth.

(iii) Overgrazing depletes the vegetation cover making the soils vulnerable to erosion.

(iv) Irrigation and soil drainage can cause soil acidification and salinisations while the use of chemical fertilizers and pesticides, contribute to a reduction in soil capillarity.

(v) Industrial pollutants such as heavy metals destroy the chemical composition of soils.

Effects of soil degradation

Soil degradation can lead to the following:

(i) Loss of fertile soil

The topsoil has most of the important plant nutrients and once these are lost, the soil becomes unproductive.

(ii) Deterioration of the water quality

Increase in the turbidity of water due to presence of soil particles and the contribution of nitrogen and phosphorus from agricultural inputs and industrial pollutants, can result in eutrophication (increased growth of aquatic plants in water bodies).

(iii) Siltation of dams, streams, lakes and rivers

Deposition of silt in water channels leads to reduced volumes of water held and hence disastrous floods may result.

(iv) Increased natural disasters

Mudslides and floods become more frequent due to low water infiltration and siltation of water bodies.

(v) Loss of biological diversity

Changes in chemical composition of soils results in alteration of soil pH. This influences the soil organisms which flourish in the soils.

(vi) Loss of arable land and grazing fields

Crop roots may be exposed and sometimes the whole crop is washed away. Gullies may form which inhibit cultivation operations. Floods may deposit silt

over the farming land and grazing fields.

(vii) Inadequate water during dry periods

Due to high surface run-off and low water infiltration, underground water reserves will not have adequate water hence the water table becomes low. As a result of siltation, the shallow water bodies evaporate easily.

(viii) Dust storms

Wind erosion causes dust storms particularly in overgrazed areas and where tillage is done during dry periods.

(ix) Reduced carbon storage in soils

By changing the composition and structure of soils, agriculture makes it more difficult for carbon dioxide to be stored in soils. Conversion of forest into cropland significantly reduces the amount of carbon dioxide dioxide storage in soil. This contributes to more greenhouse effects.

Control of soil degradation

Soil degradation measures can be broadly categorised as:

(a) Biological or cultural measures.

(b) Physical or structural measures.

(a) Biological or cultural control measures

These are farming practices that apply use of vegetation to minimise soil erosion. Cultural measures are all farming practices which help to reduce soil erosion.

Biological or cultural measures include the following:

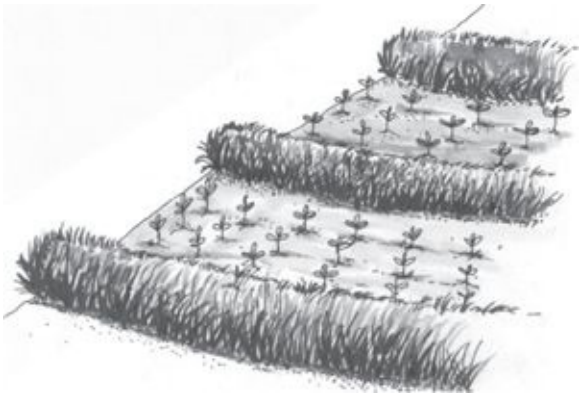


Fig. 1.7: Grass strips .

(i) Planting grass strips/filter strips

These are strips of permanent grass or legumes grown between crops to reduce the speed of flowing water and filter out soil. The strips are about two metres wide and are established along the contours. They gradually form bench terraces after several years of existence. The distance between one strip and another depends on the slope of the land. The following are the recommended distances between strips in the corresponding slopes.

Slope	**Distance between strips**
55% and above	3m
14 – 55%	3 – 5 m
12 – 13%	5 – 15 m
5 – 12%	15 – 20 m
0 – 5%	35 m

(ii) Planting cover crops or applying green mulch

The growing of cover crops such as sweet potatoes, spreading beans, grasses, cucumbers provides a soil cover which reduces the impact of rain drops on the soil, encourages higher water infiltration, and minimises the volume of surface run-off. When the leaves of the cover crops fall, they decay and stabilise the soil by improving the soil structure thus reducing erodability of soil. The cover crops also reduce excessive heating of the soil by the sun and the loss of volatile nutrients.

(iii) Grassed water ways

These are channels planted with grass at their bases. They lead water from the farm to safer grounds. The vegetation helps reduce the speed of water and traps soil.

(iv) Contour farming and strip cropping

In contour farming all farming operations such as ploughing and ridging are done along the contours or across the slope. In strip cropping, different crops are planted in strips along the contours and harvested at different times so that there is a strip of crops in the field at any given time. Crop rotation principle is used in strip cropping and grass must be included in the programme.

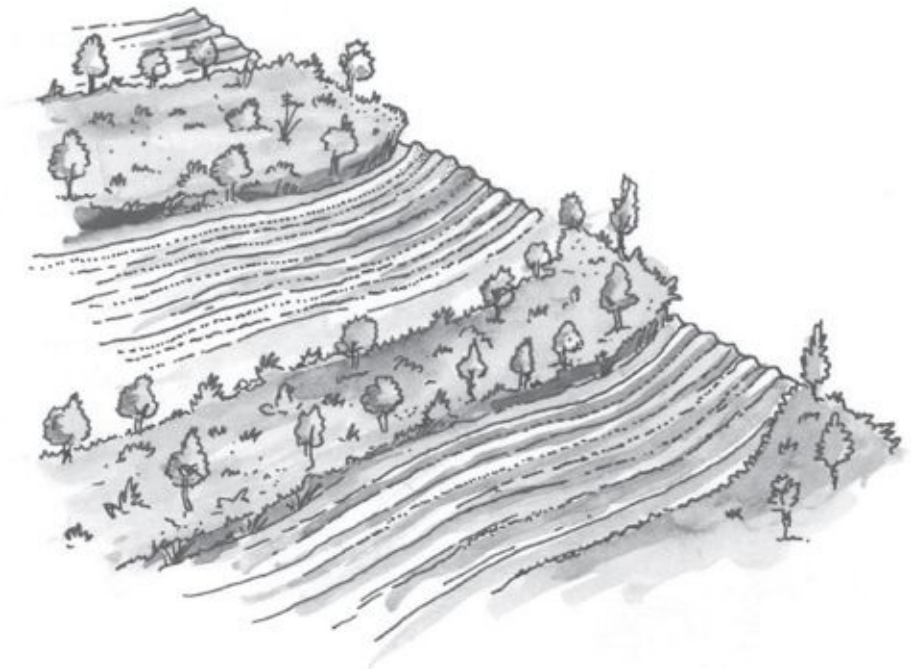


Fig. 1.8: Contour farming and strip cropping .

(v) Mulching

This is the covering of the soil surface with dry vegetation or plastic materials such as polythene sheets. The vegetation materials commonly used as mulch are cut grass, banana leaves, maize stalks, sisal waste and coffee husks.

The uses of mulches in controlling soil degradation include:

(a) Preventing splash erosion and loss of soil moisture through evaporation.

(b) Maintaining the soil structure by preventing strong hitting of soil particles by the raindrops. When organic mulch decomposes, it releases organic matter into the soil hence improving the soil structure and its fertility.

(c) Encouraging high water infiltration as speed of surface run-off is reduced by the mulch.

> **Note:** It is advisable that mulching be done at the start or end of the rainfall season depending on the rainfall pattern of a region.

(vi) Afforestation/Reafforestation

Afforestation is the planting of trees in areas where there have been none while re-afforestation refers to planting trees where forests have been cleared.

Trees play the following crucial roles:

- They act as windbreaks thus reducing the carrying away of topsoil by wind.
- They leaves intercept raindrops hence reducing their impact on the soil resulting in less splash erosion.
- When their leaves fall and decay, they help to improve the soil structure by binding together the soil particles thus making the soil less vulnerable to erosion.
- Trees create a suitable micro climate for rainfall formation.
- Trees provide shade hence reducing the heating effect of the sun on the soil.
- Tree roots bind soil particles together hence reducing the erodability of the soil.
- Trees reduce the speed and volume of run-off by encouraging water infiltration.

(b) Physical or structural measures

These are soil and water conservation measures that involve use of constructed structures to help control soil erosion. Some of the structures may be used together with vegetation. They include:

(i) Stone lines

These are rows of stones heaped along the contours. They trap soil being washed away and reduce the speed of run-off water. This encourages water infiltration into the soil. Over time, stone lines will form bench terraces.

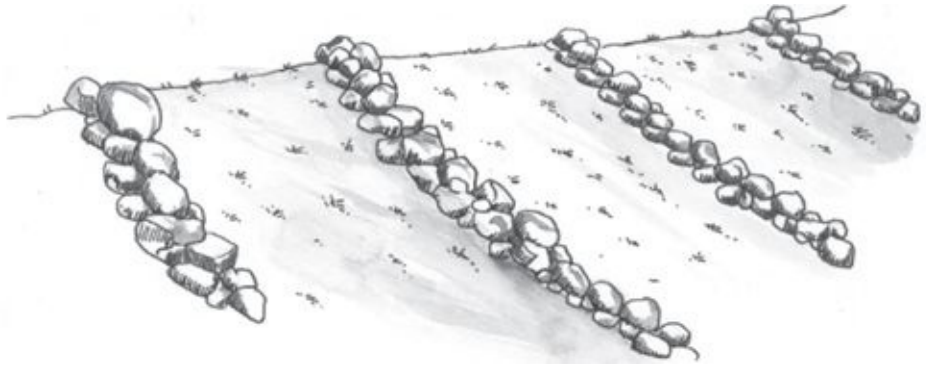


Fig. 1.9: Stone lines on a slope .

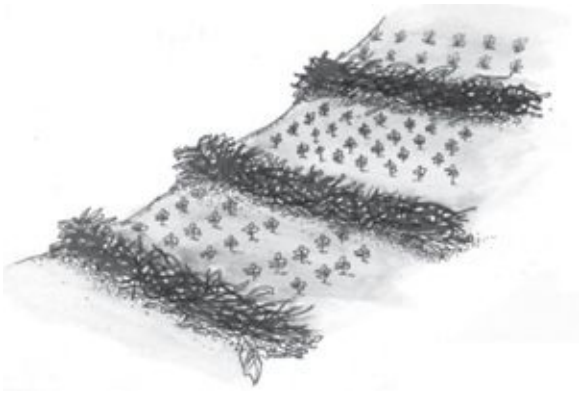


Fig. 1.10: Trash lines .

(ii) Trash lines

These are heaps of crop residues made along the contours. They help trap soil and reduce the speed of run-off water down the slope facilitates water infiltration into the soil. Trash lines can be made of heaps of maize stalks, wheat straw or grass which also add nutrients into the soil when they decompose.

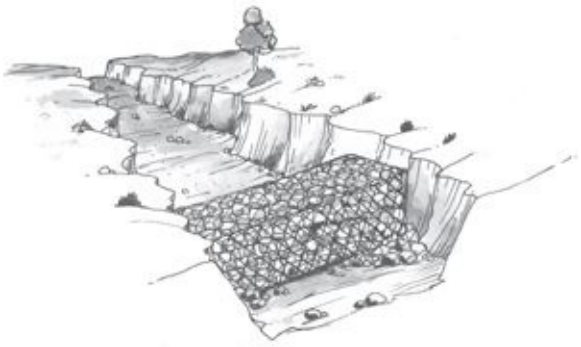


Fig. 1.11: Gabions/porous dam/check dams .

(iii) Gabions/porous dams/check dams

These are boxes of galvanised wire mesh filled with stones. They are built across slopes and gullies. The gabions are very heavy and thus able to resist the strong force of fast running waters in gullies or streams. Gabions vary in size, from small to very large. They can be made on site or brought when already made.

Gabions slow down the speed of run-off water. As water passes through it, it reduces its erosive ability. They also trap the soil being washed down the stream. These structures are placed either at the gulley bottoms or arranged in rows along the contour on slopy land.

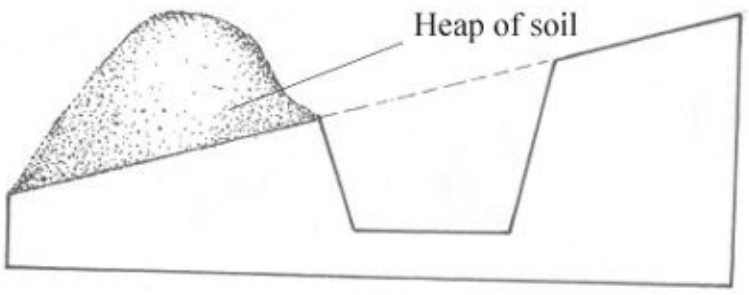


Fig. 1.12: Bunds

(iv) Bunds

These are banks of earth built along the contours. The interval between one bund and the next depends on the slope of the land. They are closer on steep slopes and wider on less slopy land that is, they may be built 25 m apart. The banks may be reinforced by planting grass on the soil heaps. Bunds have a base of 1–2 m wide and 0.6 m high.

(v) Ridging

This involves making raised heaps of soil along contours to conserve soil and water. Tuber crops like irish potatoes and sweet potatoes are planted on the ridges. The ridges along the contours could be joined by others across the contours at intervals of 3-4 m. This makes ‘tied ridges’ which prevent run-off along the furrows.

(vi) Cut-off drains/Diversion ditches

These are channels made to drain out water from the farm before it causes damage in the form of erosion. They are constructed in steep slopes where occasional large quantities of water flow down the slopes. That water flow may be destructive if it passes through arable land. Therefore, the flowing of water must be diverted and channelled to natural waterways, rocky grounds and grasslands.

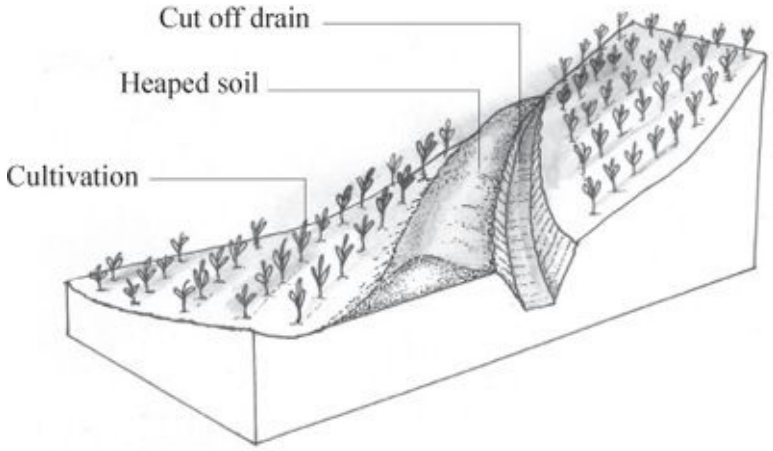


Fig. 1.13(a): Diagram of cut-off drain .

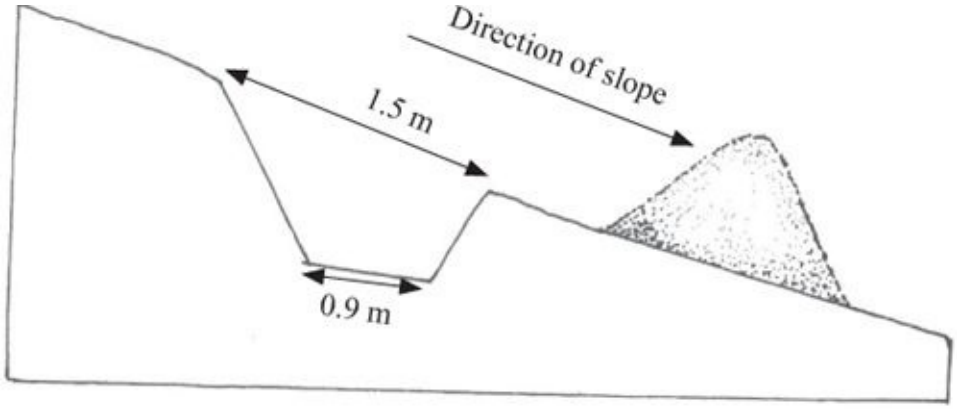


Fig. 1.13(b): Cross-section of cut-off drain .

Procedure of constructing a cut-off drain

- Measure and mark the layout of the drain.
- Dig out the channel.
- Remove soil from the channel and heap it on the lower side of the drain.
- Plant grass on the ridge to stabilise it.

The width and depth of the cut-off drain is determined by:

- Expected volume of run-off: A large volume of surface run-off water requires wider and deeper cut off drains.
- Length of the slope.
- Soil depth.
- Soil type/bed rock: Soils that saturate quickly, such as sandy soils, need a deeper cut-off drain in order to facilitate deeper water infiltration. Soils with a bedrock near the surface require shallow cut-off drain.

(vii) Terraces

A terrace is an embankment or ridge of soil constructed across a slope to control water run-off and minimise soil erosion. The main function of a terrace is to decrease the length of slope. The rate of erosion is proportional to the length of the slope. There are many types of terraces that can be constructed depending on the need of the farmer.

Types of terraces

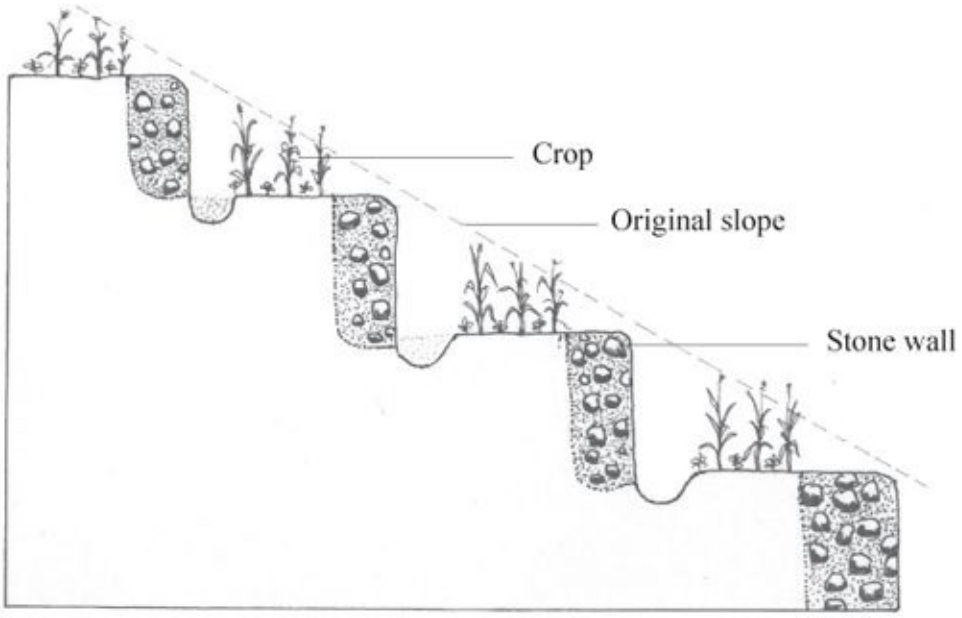


Fig. 1.14: Bench terrace .

(a) Bench terraces

These are constructed on steep slopes of 35% to 55% slope gradient where high value crops are grown for example, tea and coffee.

The banks of a bench terrace are virtually vertical. They may be protected by planting grass or built with concrete walls. Bench terraces are very expensive to construct hence a justification for use under high value crops.

Bench terraces may be made through:

- Escavation of the slope to form a fairly flat area.
- Establishment of grass strips along the contour, these trap soil and over a period of time will form benches.
- Construction of a terrace where soil is heaped on the upper side and is stabilised by planting grass on the ridge. This later transforms into bench terraces.

(b) Broad based terraces

These terraces are wide at the base (3 m or more) and about two thirds of a metre high. They have shallow channels and are constructed using heavy machinery such as graders.

These are constructed on slight slopes with a 2-12% slope gradient where soils are deep and widely spaced.

(c) Narrow based terraces

These terraces have narrow bases. They are made in areas with a 12-20% slope and are usually constructed by hand along the contours. They are more closely spaced than the broad based terraces.

(d) Level terraces

These are terraces constructed for the purpose of retaining water for long periods of time. They have no outlet channels but act as retention channels. They are suitable in arid areas where there is scarcity of water.

(e) Graded terraces

These are terraces constructed in such a way that they direct excess water out of the farm at a low speed to areas planted with vegetation. They are designed to ensure a slow flow of water out of the farm. They are commonly found in high rainfall areas.

Practical Activity 1

1 . Visit an area with degraded soils, observe and record forms of soil degradation.

2 . Visit an area with degraded soils and carry out activities of controlling the soil degradation.

Revision Exercise 1

1 . What is soil degradation?

2 . Describe the forms of soil degradation.

3 . Explain the causes of soil degradation.

4 . Describe the consequences of soil degradation.

5 . Explain the biological measures of controlling soil degradation.

Topic 2

Crop Production

Unit 2: Crop Improvement

Unit 3: Crop Storage and Processing

Unit 4: Pasture Production

Unit 2 Crop Improvement

Specific objectives

By the end of this unit, the you should be able to:

(a) Explain the meaning of the term crop improvement.

(b) State the aims and objectives of crop improvement.

(c) Explain the methods of crop improvement.

Introduction

Farmers aim at producing very high yielding crops which meet needs of consumers.

Crop yield and physical appearance (phenotype) of a crop depends on the inherited characteristics (genotype) of the crop and the environment. Environment includes to better crop husbandry techniques such as proper crop nutrition, adequate soil moisture, appropriate pest, disease and weed control. Plant breeders manipulate the genotypes of plants to produce certain desired characteristics.

Meaning of crop improvement

Crop improvement simply refers to plant breeding.

Plant breeding is defined as the art and science of changing the genetics of plants in order to produce desired characteristics.

Crop improvement is culturally done where farmers select superior crop plants and save the seeds for future use.

In crop improvement, plant breeders identify superior characteristics in plants, trace their location in the DNA strands and try to manipulate them through crossing with an aim of developing a new plant of better economic value.

Aims of crop improvement

There are several objectives of crop improvement aimed at increasing crop qualities and quantities (crop yield).

(a) To improve adaptation of plants to ecological conditions. Maize variety NSCM41 and CCA do well in the low altitude zones of Malawi where the rainy season is short.

(b) To increase crop yields. NSCM41 maize variety for example, gives higher yields than the local varieties.

(c) To improve the market quality of the product.

(d) To develop early maturing varieties.

(e) To improve the nutritional content of edible parts.

(f) To improve abiotic stress tolerance such as drought, salinity and cold.

(g) To create biodiversity by developing new varieties through crossing existing cultivars with their wild relatives.

(h) To develop crops which are well adapted to modern production techniques such as mechanical harvesting.

(i) To improve on sugar content especially in sugarcanes.

(j) To improve the keep quality of the crop produce.

(k) To increase the market value of crop products such as ripening quality, taste and texture.

(l) To increase resistance to pest and disease for example, groundnut variety RG1 is bred to resist rosette disease.

(m) To improve water use efficiency.

(n) To increase nutrient use efficiency especially in areas where soil fertility n gone low.

(o) To develop crop varieties which compete favourably with weeds for space, nutrition and light.

(p) To develop crops with high responsiveness to nitrogen fertilizer.

(q) To develop plants with greater physiological efficiency, thus making better use of environmental conditions available.

(r) To develop crops with ease of adaptations to new agricultural areas.

Methods of crop improvement

Crops may be improved through the following methods:

1. Introduction of new crop varieties.
2. Selection.
3. Hybridisation.
4. Hybrid varieties development.
5. Synthetic varieties development.
6. Genetic engineering.

1. Introduction of new crop varieties

This involves importation of superior crop varieties from other countries into Malawi.

This stock serves as multiplication and propagation for the new area. For success, the ecological conditions at the country of origin must be similar to the conditions where the crop is to be grown.

For example maize variety Ukiriguru Composite A (UCA) was imported from Tanzania for high altitude and high rainfall areas of Kirk range, Shire highlands, Lilongwe plains, chitipa plains and Namwera areas.

2. Selection

Farmers constantly select high performing crops in their farms.

In selection, plant breeders use the following techniques:

(a) Mass selection.

(b) Pureline selection.

(a) Mass selection

This is the selection of crops based on their phenotype and general performance. The seeds from the selected plants are bulked up for the next generation. It is most effective for highly heritable traits. The limitation of this method is that there is a large influence of the environment on the development, phenotype and performance of the plants.

(b) Pureline selection

This involves the following stages:

(i) Numerous superior plants are selected from a genetically variable population.

(ii) Progenies of the individual plants selected are grown and evaluated by simple observation frequently over a long period.

(iii) When selection can no longer be made on the basis of observation alone, trials are undertaken involving measurements to determine the remaining selections are superior in yielding ability and other aspects of performance.

Any progeny superior to an existing variety is then released as a new pureline variety.

3. Hybridisation

This involves the combination of desirable genes found in two or more different varieties to produce pure-breeding progeny which is superior in many aspects to the parental types.

The greatest challenge in hybridisation is that it creates a great variability due to the enormity of the genes involved. The parent varieties are usually inbred before crossing them in hybridisation.

Stages of hybridisation

(a) Choosing parents.

(b) Cross-pollinating the parental lines.

(c) Self pollinating pure lines.

4. Hybrid varieties development

This involves crossing two different genotypes to produce a hybrid. It differs from hybridisation in that no attempt is made to produce pure-breeding population, only the hybrid plants are sought. The advantage of hybrid plants is that it possesses hybrid vigour or heterosis that is, they show superior characteristics than either of the parental plant. These include increased rate of growth, greater uniformity, early flowering and increased yield.

5. Synthetic varieties development

A synthetic variety is developed by intercrossing a number of genotypes of known superior abilities. These genotypes are known to give superior hybrid performance when crossed in all combinations. Synthetic varieties have hybrid vigour and ability to produce seeds which can be used in succeeding seasons. Due to these benefits they are popular in growing many species of crops.

6. Genetic engineering

This is a new method in crop improvement 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.

Practical Activity 2

1. Visit an organisation involved in crop improvement and identify the methods of crop improvement being researched on.
2. Visit a crop research station and observe activities involved in crop improvement.

Revision Exercise 2

1 . Explain the meaning of crop improvement.
2 . State the aims and objectives of crop improvement.
3 . Explain genetic engineering as a method of crop improvement.
4 . What is hybridisation?
5 . Differentiate between hybrid varieties and synthetic varieties.

Unit 3 Crop Storage and Processing

Specific objective

By the end of this unit, you should be able to describe the processing of various crops for storage.

Introduction

Crop storage means keeping the harvested crops in good conditions so that they remain fit for future use. When conditions are not suitable for storage or immediate marketing of fresh produce, processing is done. Processing is the changing of raw forms of produce into a finished product of higher value which can be preserved for future use.

Some of the processing methods used by small scale handlers include:

- Drying.
- Canning.
- Preserving.
- Fermenting.
- Freezing.
- Juicing.

Processing and storage of maize

In processing a maize crop the following practices are carried out:

(a) Dehusking

This involves removal of the husks from the maize cobs. Dehusking is done when the maize crop has dried and is ready for harvesting. Dehusking is done by hand.

(b) Shelling

This is the removal of maize grains from the cobs. It can be hand done or mechanically done by use of shellers.

(c) Drying of the grains

The fresh maize cobs or shelled grains may be laid directly on a mat black in colour and allow the sun and wind to dry up the crop.

Maize grains may also be dried using solar driers, electric driers and forced air dehydrators. The grains should be dried to 11-13% moisture content.

Maize grains should be dried before storage for the following reasons:

(i) To minimise incidences of moulds developing on the testa which causes the deadly aflatoxins.

(ii) To make the testa hard to resist insect attack.

(iii) To reduce transpiration rate in grain hence preserve for long period.

(iv) To prevent germination of seeds when they are in the store.

(d) Cleaning the grains

The shelled grains are winnowed to remove chaff and other foreign materials. Winnowing machines or fanners are used in large scale operations.

(e) Dusting

The maize grains are then treated with appropriate pesticides to protect them against storage pests.

(f) Packing

The produce is then placed in standardized bags in readiness for marketing.

Processing of groundnuts

Harvested groundnuts may be stored unshelled or shelled. The harvested groundnuts are dried before storage. The nuts are dried by placing them on a black mat surface and allowing sun and wind to dry up the crop. A layer of cloth can be draped loosely over the spread crop to protect it from insects and birds while drying. It can also be dried using forced air dehydrators, solar driers or electric driers. The shelled crop is winnowed before packing in standard bags for marketing. The clean dry crop can be processed by oil processing equipment into peanut oil, groundnut butter, and other products.

Processing of sweet potatoes

Fresh sweet potatoes may be stored in specially built silos or conserved by drying.

(a) Conserving in silos

The following practices are done on sweet potatoes before they are stored in silos:

- **Cleaning:** The fresh tubers are cleaned to remove all dirt and debris.
- **Selection:** Selection begins during harvesting; those tubers with mechanical bruises or pest damages are sorted out.
- **Drying:** The tubers are spread in a cool, dry, shaded place to reduce the moisture content.
- **Storage in silos:** The bottom part of the silo has grass where the tubers are placed. The tubers are carefully stacked in the pit. They are then covered with grass, then banana leaves and a top layer of soil. Short tubes of bamboo stems are inserted into the pile to help in ventilation and heat loss.

(b) Conserving by drying

The tubers are cleaned and cut into slices 2 to 4 mm thick. They are sun dried for about 4 days. The dry slices are then stored in barns. They can be ground into flour.

Processing of cassava

After harvesting, fresh cassava tubers are peeled and sliced into small chips. The chips may be dried directly in the sun or by use of a solar drier. The dried chips can be stored in sacks for later use. They can be ground into flour and used in a variety of ways such as cooking and baking. The large tubered bitter varieties used for flour production must be processed to remove cyanogenic glucosides. The flour is mixed with water and left to stand for about 5 hours. Within this time the cyanogenic glucosides are broken down by linamarase enzyme resulting in hydrogen cyanide which escapes in the atmosphere. The paste is then dried into flour again.

> **Note:** This activity should be carried out in an open place to avoid poisoning by hydrogen cyanide gas.

Processing of Amaranthus (*Bonongwe*)

Amaranthus being leafy greens may be harvested when abundant and preserved as dried vegetables or placed in a freezer.

Drying

Amaranthus can be dried in a home oven. The leaves require blanching before drying. Blanching is done by placing them in boiling water bath or in steam for about 2 minutes. This ends certain enzymatic reactions in the leaves and helps retain colour their and flavour. The prepared (blanched) leaves are placed on baking or metal screen trays. The oven temperatures are set at 60°C and the door left open 2 to 4 inches for ventilation. Drying time can be reduced if ventilation is increased.

Freezing

The leaves are blanched before freezing. Freezing temperatures are best set between -21°C to -18°C. Packages for freezing should be moisture proof and vapour proof with as little air as possible to prevent oxidation during storage. The packages are then placed in a freezer.

Processing mangoes

Mango fruits are highly perishable hence they cannot be stored for long when ripe. They are best stored in processed form. Mangoes can be processed into juice and chutney. The fruits are cleaned then simmered in water in a stainless steel, glass or enamel pot. When tender, the fruits are cut into pieces and pressed through a food mill or hand operated fruit press. Lemon juice can be added to taste. The juice is then frozen or canned for storage.

Importance of crop storage

(i) To save seeds required for planting.

(ii) To provide food between harvesting seasons.

(iii) To provide farm animals with good food even during periods of pasture scarcity.

(iv) To provide a safe keeping for harvested produce for consumption all the year round.

(v) To reduce and avoid heavy losses which may otherwise occur in the field.

Types of stores

(a) Traditional stores

These vary with communities, types of produce to be stored and the construction materials used. Some communities put crop produce in simple containers or pots; others used to leave the produce hanging on poles outside in the homesteads. Nowadays, granaries are used in most farming areas though their structural design exposes the produce to rain and to attacks by insects and rodents. However, modifications have been made to traditional store structures by constructing the floors and walls using timber and the roofs with corrugated iron sheets.

Fig. 3.1: Traditional store (nkhokwe) .

(b) Modern stores

Modern storage structures are used for bulk storage of grains. They handle large quantities of grains. Examples are, silos and bins such as Hermetic Cyprus bins. They conform to storage requirements.

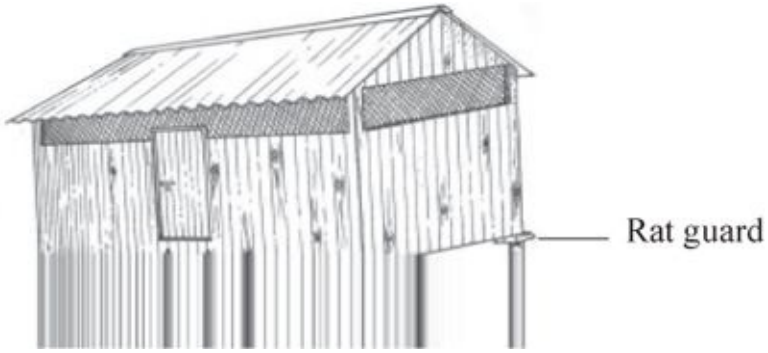


Fig. 3.2: Modern store .

Good storage structures should have the following features:

(i) Vermin-proof.
(ii) Well ventilated.
(iii) Rain-proof.
(iv) Easy to load and off-load.
(v) Easy to clean.
(vi) Damp-proof.

Preparation of a store

Before placement of produce in a store, carry out the following preparations:

(a) Ensure it is clean. The floor should be swept clean. Remove all the old crop residues. Dust the floor, walls and roof with appropriate pesticides.

(b) Place wooden dunnages on the floor to prevent the moisture being conducted from the ground to the storage bags or grains.

(c) Place the storage bags in stacks and treat every stack with pesticide. After stacking, seal the store and fumigate.

(d) Keep the area around the store clean. Clear all vegetation in the store surroundings.

(e) Ensure the grains to be stored are clean and properly dry (11-13% moisture content).

Practical Activity 3.1

1. Visit local farmers and observe the various methods of processing crops for storage.
2. Visit organisations involved in processing of various crops and record the methods involved.

Revision Exercise 3

1 . Define the term processing.
2 . Explain how cassava flour can be made free of cyanides.
3 . What is blanching in processing crops?
4 . Give the features of a good storage structure.
5 . Why should blanching be done?

6 . State the reasons for storing crops.

Unit 4 Pasture Production

Specific objectives

By the end of this unit, you should be able to:

(a) Explain the meaning of the term ‘pasture’.

(b) Explain the importance of pasture production.

(c) List the types of pasture.

(d) Describe methods of pasture establishment.

(e) Establish pasture.

(f) Manage pasture.

(g) Conserve pasture.

(h) Describe the factors that affect the quality of pasture.

Introduction

In livestock production, feeding animals on quality fodder and pasture is necessary.

Proper feeding is one of the essential livestock routine management practices. Most livestock farmers in Malawi do not regard pasture as important as food crops though they form the bulk of ruminants’ diet.

Natural grasslands do not have productive types of pasture and with increasing human population, there is a great need for farmers to invest in more productive types of pasture in a bid to improve livestock nutrition.

Meaning of pasture

Pasture are grasses and legumes found naturally growing in fields or cultivated on pieces of land for feeding livestock.

Importance of pasture production

- Pasture provides feeds for livestock. It forms the bulk of ruminant animals' diet.
- Low growing pasture crops create a soil cover hence reducing soil erosion
- Growing pasture reduces volumes of surface run-off by encouraging water infiltration into the soil.
- Pasture grasses and legumes could be used in a crop rotation. The fibrous nature of grass roots helps in improving soil structure and decaying leaves stabilise soil.
- Leguminous pasture crops such as *Desmodium*, *Centrosema pubescenes* and *Stylosanthes spp* . and with the aid of Rhizobium bacteria improve soil nutrient content by fixing nitrogen from soil air into nitrates.
- Pasture grasses could be used in crop rotation programmes to help break the development cycles of pests and disease-causatives. Some grasses like rhodes grass show some resistance to insect pests and diseases.
- Pasture can also be established to increase production in acidic soils which may not support crop production.
- To utilise non-arable land for pasture whilst using arable land for crops.

Practical Activity 4.1

Visit nearby farms and observe animals grazing.

Types of pasture

Pasture can be classified into two: **natural pasture** and **exotic pasture.**

(a) Natural pasture

These are naturally growing grasses and legumes. They establish through natural regeneration. They are found in uncultivated grasslands and dambos.

The table below shows some of the common grass species in natural pastureland depending on altitude.

1500 m above sea level and below	1500 – 2000 m above sea level	Above 2100 m above sea level
Hyparrhenia spp	*Themeda triandra*	*Exotheca spp*
Themeda triandra	*Hyparrhenia lecomtei*	*Agrostis spp*
Andropogon schirensis	*Exotheca abyssinica*	*Trachypogon spicatus*
Bewsia biflora	*Monocymbium ceresiiforme*	*Monocymbium ceresiiforme*
Anthephora acuminata	*Brachiaria serrata*	
Rhynchelytrum nyassanum	*Melinis maitlandii*	
Andropogon complectens	*Protea spp*	
	Rhychelytrum stolzii	
	Rhychelytrum nerviglume	
	Rhychelytrum stuposum	

Table 4.1: Some common grass species in Malawi .

Natural pasture can be improved through the following ways:

(i) Introduction of suitable legume crops.

(ii) Application of manure at the onset of rains.

(iii) Regular weeding.

(iv) Controlled burning to remove the fibrous stem remains after grazing period.

(v) Proper stocking rates.

(vi) Harvesting pasture at the appropriate time.

(b) Exotic pasture

This is pasture planted by man. It is also called **cultivated pasture** or **pasture ley.**

These grasses and legumes have high productivity compared to natural pasture. They have high dry matter and crude protein content.

Some commonly cultivated grasses includes;

• Rhodes grass (*Chloris gayana*).

• Buffel grass (*Cenchrus ciliaris*).

• Napier grass (*Pennisetum purpureum*).
• Guinea grass (*Panicum maximum*).

Some commonly cultivated leguminous pasture include;

• *Stylosanthes spp* (Stylo).
• *Centrosema spp* (Centro).
• *Macroptilium spp* .
• *Macrotyloma spp* .
• *Desmodium spp* (Desmodium).
• *Neonotonia spp* .

The following leguminous shrubs are also grown in some farms:

• *Leucaena leucocephala* (Laucaena).
• *Faidherbia albida* .

When establishing these cultivated pasture, a farmer may plant a pure stand or a mixed stand pasture.

(i) Pure stand pasture

This is a pasture crop which is grown as one type only in a field. The stand can be either leguminous crop or grass crop but not both.

A pure stand pasture however, may have a mixture of grasses or only one grass species and similarly for legumes a mixture of different legume species or one species of legume.

Advantages of pure stand pasture

• It is easier to control weeds using herbicides in a pure stand pasture than in a mixed stand pasture.
• There is better establishment as there is less competition for nutrients, space and light unlike in the mixed stand where competition is stiff between the crops.
• 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 rely on unlike in mixed stand pasture.
• Lower yield per unit area in comparison to a mixed stand.
• There are more cases of bloat in aminals if the pasture crops are leguminous.

• The feed may not be very palatable if fed to livestock alone.

(ii) Mixed stand pasture

This refers to establishment of leguminous crops and grass crops in the same piece of land. It may be established by planting pasture legumes in an existing grass pasture.

Advantages of mixed stand pasture

• Grass-legume pasture have higher nutrient value than either of them separately.
• They improve the soil fertility due to nitrogen fixation by the legumes and hence there is less usage of nitrogen fertilizers.
• Higher yield per unit area are realised compared to pure stand pasture.
• Animals are less prone to bloat when grazed on mixed pasture.
• There is guaranteed yield in case of failure of one crop.
• Grass-legume mixture is more palatable to livestock.
• There is maximum soil exploitation as different crops have different soil nutrient requirements.

Disadvantages of mixed stand pasture

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

Practical Activity 4.2

Visit pastureland and list the types of pasture.

Methods of pasture establishment

Pasture are either row planted or broadcast under the following methods:

(a) Direct sowing

The seeds or vegetative materials are planted directly into a well prepared seedbed. Direct sowing gives rapid pasture establishment and defoliation can be done earlier. This method of pasture establishment is suitable where there is low

rainfall and shortage of fertilizers.

Vegetative materials such as canes and rooted splits are established directly in the field. The field is prepared and holes dug as per the spacing of the pasture.

Pasture seeds can also be established directly either by drilling or by broadcasting. The field is prepared to a fine tilth since most pasture seeds are very tiny. Drilling is done manually or by use of seed drills in case of large scale. Broadcasting on the other hand is also done on a finely prepared field.

After planting the pasture seeds, either by broadcasting or drilling, rolling is carried out. It involves compacting the soil by use of rollers.

Importance of rolling

- It improves the seed soil contact hence faster germination.
- It prevents seeds from being blown away by wind.
- It controls soil erosion.

(b) Undersowing

The pasture crop is established under an already growing crop, usually referred to as a **nurse crop** such as maize. The nurse crop is established first and the pasture seeds planted immediately after weeding the nurse crop. Conditions which favour undersowing are high rainfall and availability of fertilizers.

(c) Oversowing

This is the establishment of a pasture legume in an existing grass pasture. Before sowing of pasture seeds, growth of existing grass is checked through slashing, burning or hard grazing and the soil disturbed slightly. About 200 – 400 kg single super phosphate fertilizer per hectare is applied and mixed with the soil. The legume seeds are then planted. The grass is regularly cut short until pasture legume is fully established. Ensure the legume seeds are inoculated with appropriate rhizobial bacterial strain before planting.

Advantages of oversowing

- 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

• Higher rodent and insect population.

• It requires high management skills.

Pasture establishment

Correct procedures must be followed to ensure better pasture establishment. These are:

(a) Proper time for pasture establishment

For successful pasture establishment in the field, planting should be done at the appropriate time. The crop should be planted at the onset of the rains. In Malawi, planting should be carried out latest by the end of January.

(b) Seedbed preparation

The land is cleared and ploughed deeply during the dry season in order to eradicate perennial rhizomatous weeds such as couch grass. Cultivation increases soil permeability, oxygen content and nitrate formation all of which assist the growth of seedlings. The land is then harrowed to a fine tilth but in sandy soils, very fine tilth can result in low emergence of seedlings. This is because the soil structure is destroyed, bulk density increased, aeration reduced and water infiltration impeded. An alternative to fine tilth seedbed is the use of direct drilling. Leveling and rolling of seedbed is then carried out in readiness for planting.

(c) Selecting appropriate type of pasture seeds

The performance of a pasture is determined by several factors. Some of these factors include:

• Percentage seed purity.

• Percentage of germination.

• Free from pests and disease attack.

• Adaptability to the ecology of the area.

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

Different grasses and legumes are adapted to different ecological zones for example, *Desmodium spp* are better adapted in Lilongwe plains and Shire highlands.

(d) Calculating the seed rate

The seed rate is the quantity of seeds planted per hectare. It is usually expressed in kilograms per hectare (kg/ha). To calculate the seed rate, you need to know the expected plant population per hectare, the seed size, (expressed as the number of seeds per kilogram), the purity percentage and germination percentage of the seeds.

$$\text{Seed rate} = \frac{\text{expected plant population per hactare}}{\text{seed size} \times \text{purity \%} \times \text{germination \%}}$$

For example, calculate the seed rate for a certain grass species where:-

Seed size: 200,000 seeds/kg

Purity: 80%

Germination percentage: 60%

Expected plant population 600,000 plants.

$$\text{Seed rate} = \frac{600{,}000 \times 1 \text{ kg}}{200{,}000 \times 0.8 \times 0.6 \times 1 \text{ ha}}$$

$$= 6.25 \text{ kg/ha}$$

(e) Treating the pasture seeds

This involves all practices carried out on the planting materials to improve their germination ability and encourage successful establishment.

Seed treatment includes:

- Shelling.
- Scarification.
- Cleaning.
- Inoculation.
- Pelleting.

- **Shelling:** This is the removal of the pod especially in leguminous pasture such as desmodiums. It can be done by pounding the pods in a mortar (*mtondo*) and winnowing them.
- **Scarification:** This is the nipping the hard testa of some legume seeds in order to speed up water penetration. This can be done mechanically or by immersing the seeds in hot water for a few minutes.

- **Cleaning:** This involves removal of chaff and off-type seeds. This improves the seed purity.
- **Inoculation:** This is coating the legume seeds with a nitroculture of the right rhizobial strain. This encourages nodule formation hence boosting nitrogen fixation.

The following table shows successfully inoculated legumes with their correct strains of *Rhizobia spp* .

Strain of *Rhizobium spp*	Pasture inoculated
Rhizobium trifolli	Clover
Rhizobium melioti	Lucerne
Rhizobium lupini	Lupin
Rhizobium japonicum	Soy beans

Procedure of inoculation

(i) Mix the inoculant (material which contains the right strain of rhizobial bacteria) with cellophane paste or sticker such as milk or sugar solution.

(ii) Mix the seeds with the inoculant cellophane paste.

(iii) Add lime and mix.

(iv) Spread under a shade for 12 hours.

(v) Plant in 48 hours.

(f) Pelleting: This is sticking a thin layer of lime or gypsum around the legume seeds. These materials amends the soil pH and improves its establishment. Gypsum has acidifying effects, hence it lowers the pH. This may inhibit the activities of the rhizobium bacteria hence making inoculation unsuccessful.

(g) Sowing the pasture seeds

Sowing is done at the beginning of the rainy season to ensure that the forage is well established by the time the rain is over. Use certified seeds or disease free vegetative materials such as rhizomes or splits. Sowing of seeds is done by broadcasting or drilling in furrows at appropriate spacing. Recommended seed rate is 5-10kg/ha for most forage crops. Apply organic manure or phosphatic fertilizers during planting. Planting should be done at the appropriate depth depending on the type of planting material used; that is, seeds, splits or stem cuttings.

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. This may be due to over storage, poor storage or low germination percentage.

(ii) Poor inoculation: Non-inoculated or poorly inoculated legume seeds give plants that are not able to fix nitrogen efficiently.

(iii) Lack of enough nutrients in the soil.

(iv) Unfavourable chemical conditions.

(v) Poor drainage: Most pasture cannot survive in poorly drained soils.

(vi) Pests such as rodents and diseases if not controlled can cause death of the pasture crop.

Pasture management

The following management practices must be carried out for maintaining a good pasture crop.

(a) Applying the correct type and amount of fertilizer

This is the practice of applying fertilizers in already established pasture, it is basically top dressing. It should be carried out immediately after topping. Topping is the removal of stemmy fibrous materials left after a period of pasture grazing so as to stimulate fresh regrowth.

Various top dressing materials can be used depending on the type of pasture. Pure stand grass pasture respond well to compound fertilizer 23:21:0 + 4S at the rate of 100 kg/ha and calcium ammonium nitrate (CAN) at the rate of 100-200 kg/ha. Leguminous pasture and mixed stand pasture should be top-dressed with super phosphates at the rate of 100 kg/ha.

Importance of top-dressing

(i) To improve the nutritive value of the pasture.

(ii) To replenish soil nutrients.

(iii) To increase the total yield of the pasture.

(iv) To improve the physical characteristics of the pasture such as structure.

(v) To correct the chemical properties of the soil such as pH.

(b) Weeding the pasture land

Weeds in pasture fields are controlled by slashing, use of selective herbicides or by uprooting the weeds.

Examples of common pasture weeds include:

Fig. 4.1: Thorn apple .

• Thorn apple (*Datura stramonium*)

It is an annual herb which belongs to the family *solanaceae* . It is common in arable land and waste lands. Thorn apple 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 150 cm. It has thorny fruits which contain several dark brown seeds. The weed is effectively controlled by cultivation, slashing or application of herbicides such as 2,4-D, Paraquat, MCPA and Simazine.

• Sodom apple (*Solanum incanum*)

It belongs to the family *Solanaceae* . 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 1.8 m. Sodom apple has alternate 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 underground rhizomes, making it difficult to control. It can be controlled by cultivation and by use of herbicides such as 2,4-D and MCPA.

Fig. 4.2: Sodom apple .

Fig. 4.3: Tick berry .

• Lantana/Tick berry (*Lantana camara*)

It is a perennial shrub that belongs to the family *Verbenaceae* . It forms impermeable thickets in wastelands and grasslands receiving adequate annual rainfall. The stems are erect and can grow up to 3.6 m 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. Control measures are cultivation and by use of herbicides such as, 2,4-D and through slashing.

Reasons for weed control

(i) Weeds compete with forage crops for nutrients, moisture, space and sunlight which ultimately affect the overall perfomance 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, for example, bull thistle.

(iv) Some weeds such as *Datura stramonium* may result in livestock poisoning if fed on.

(v) Weeds shorten the life of a forage stand.

(vi) Some weeds taint the colour and flavour of milk for example, wild onions.

(c) Pests and disease control

Some of the common pests of pasture include moles, termites, armyworms and aphids. Moles can effectively be controlled by trapping, flooding and by use of rodenticides. Insect pests can be controlled by spraying the pasture with

insecticides.

Diseases like rust which attack grass pasture can be controlled by rogueing.

(d) Grazing animals on the pasture land

Grazing on pasture is termed as defoliation. The frequency of defoliation, that is how often the forage is grazed on, must be considered. The effects of early defoliation and late defoliation are listed below.

Effects of early defoliation

Early defoliation refers to grazing livestock on pasture which are less than 4 weeks old. It has the following effects:

(i) It has low dry matter yield hence low in nutrients.

(ii) It has low crude protein yield.

(iii) It has high dry matter digestibility but low digestible nutrients.

(iv) High moisture content.

(v) Early defoliation leads to gradual weakening of the stand and reduction in the life of the stand.

Effects of late defoliation

Late defoliation refers to first grazing of livestock on pasture which are more than 10 weeks old. It has the following effects on the pasture:

(i) High cellulose content.

(ii) High dry matter content.

(iii) High lignin content.

(iv) Low crude protein content.

(v) Low leaf: stem ratio hence reduced palatability.

(vi) Low digestibility.

From the discussion on effects of early and late defoliation, first grazing should therefore be done between 4 - 6 weeks after establishment and thereafter at an interval of 4 - 8 weeks depending on the pasture species. Controlled light grazing is recommended for the initial grazing. Overgrazing or undergrazing should be avoided as much as possible.

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 that is 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.

To avoid overgrazing or undergrazing, the stocking rate should be equal to the carrying capacity of a pasture. The stocking rate depends on the carrying capacity of a given pasture crop. If the stocking rate is higher than the carrying capacity, then overgrazing occurs and if the stocking rate is lower than the carrying capacity, undergrazing occurs.

The term stocking rate refers to the number of animals kept per hectare of pasture land while carrying capacity is the number of animals that can be supported by a specified given area of pasture land.

Grazing systems

There are two main grazing systems namely:

1. Rotational grazing.
2. Zero grazing.

1. Rotational grazing

Rotational grazing refers to the practice of grazing livestock on a part of a pasture for some time down to a certain level after which the animals are moved to another part of the pasture. This is organised in such a way that by the time the animals are returned to the first paddock, the pasture will have regenerated.

Methods of rotational grazing

(i) Paddocking

A paddock is a fenced portion of a pasture in which animals are confined for grazing. Paddocking, on the other hand, refers to the grazing of animals in one paddock for a short period (usually a few weeks) then moving them to another paddock. The size of paddock mainly depends on the carrying capacity of the

pasture.

There should be a watering point in each paddock. Usually a water trough is placed between two paddocks so that animals can drink from either paddock. Paddocking saves on the labour for herding and controls pest and diseases.

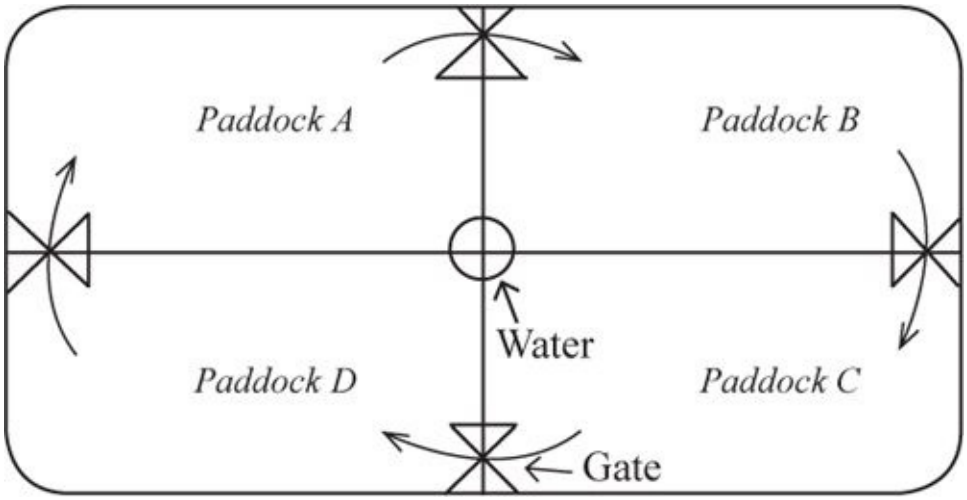


Fig. 4.4: Paddocking

(ii) Strip grazing

This refers to grazing the animals on a restricted area of the pasture for a time then moving them to new areas after the grass level has gone down. However, this method is used on very high quality pasture. The animals are restricted by use of an electric fence or other temporary fences.

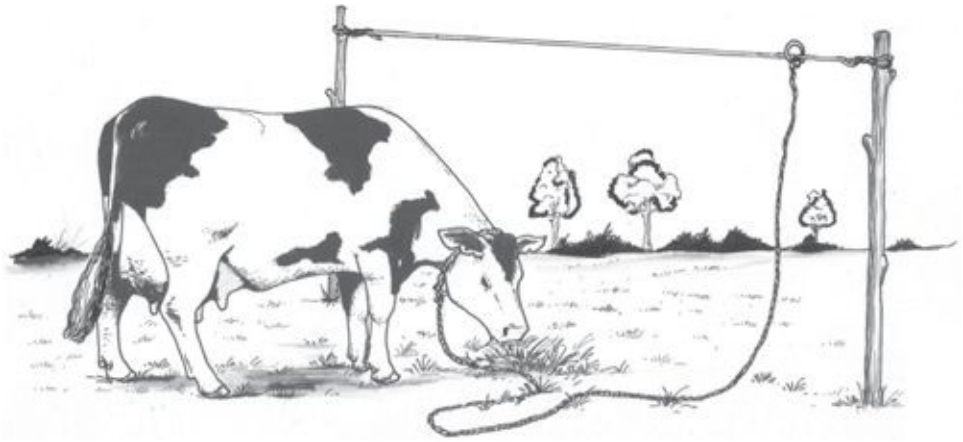
(iii) Herding

A herdsperson controls the grazing of animals by confining them to an area of pasture for some time and then moving them to another area after the grass level drops. In this method, the herdsperson looks after the animals as they graze. It is the idea behind pastro-nomadism.

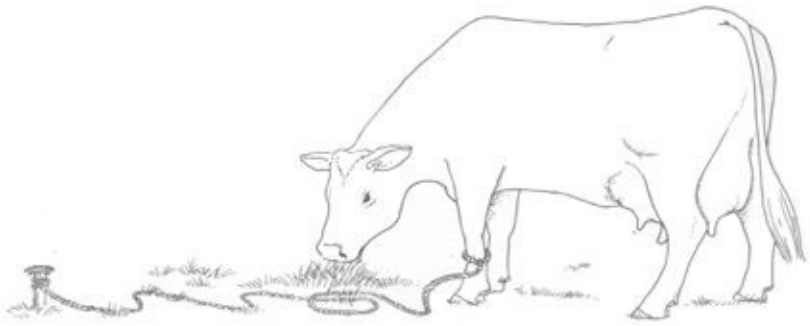
(iv) Tethering

This involves tying an animal to a post with a rope such that the animal feeds within a restricted area. Water is provided to the tied animal. When the grass level within the grazing area is reduced to a low level, the animal is moved to another spot. This method is used where only a few animals are reared and it requires regular checking on the animals by the farmer. When tying the animal, the farmer must be careful to ensure the animal cannot strangle itself. The limitation of tethering is that it causes pasture wastage through trampling and

defecation by the animal.



Running tether



Picket tether

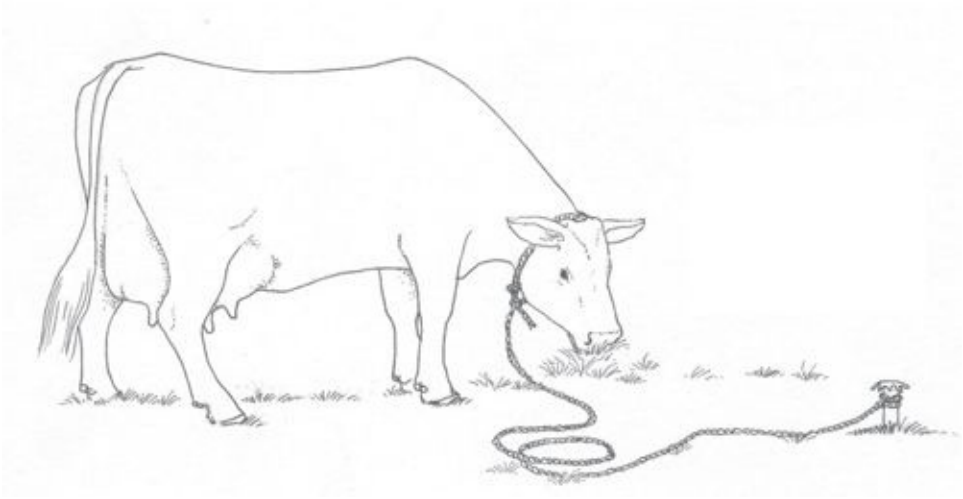


Fig. 4.5: Tethering of animals .

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

Under this system, the animals are kept in total confinement where feeds are provided to them. The structure used in housing the animals under this system of grazing is called a *stall* or a *zero-grazing unit* .

The success of stall grazing requires high management skills to achieve efficiency in routine practices such as feeding, parasite and disease control.

Advantages

- Under good management, animals have a high milk yield.
- There is quick accumulation of manure.
- It is easy to control diseases and parasites.
- There is little land space requirements that is it allows high stocking rate.
- High returns per unit area under good management.
- Animals utilise fodder much better than in pasturage.

Disadvantages

- High initial capital is required to establish and put up the animal stalls.
- Very high level of management skills are required because the farmer provides everything to the animals. For instance, the farmer must establish the maintenance ration and production ration of an animal.
- It is labour-intensive. Feeding the animals, cleaning the housing unit, observing heat signs for A.I among other routine management practices require a lot of labour.
- There is fast spread of diseases in the stall.

(e) Burning the pasture land in the dry season

At the end of the dry season, controlled burning should be carried out on the pasture.

This practice has the following benefits:

- It removes the dry fibrous herbage so that fresh pasture regrowth may occur.
- It prevents woody shrubs from inhabiting the pastureland.
- It controls parasites like ticks by burning some of the life cycle stages on the ground.
- It controls pests and diseases which might be in the soil.
- It reduces weed plants not eaten by animals.

Problems associated with burning of pasture

- It encourages soil erosion.
- It may lead to death of some pasture.
- It causes loss of soil fertility.

Pasture conservation

Forage conservation refers to the practice of preserving excess forage crop for future use.

Reasons for pasture conservation

(i) For better and full utilisation of available land. When forage is cut, further regrowth occurs especially during the rainy season.

(ii) It ensures availability of livestock feed throughout the year even during dry seasons.

(iii) It is a source of income. The conserved forage may be sold to generate income to the farmer.

Methods of conservation

Forage can be preserved through the following forms:

(a) Hay.

(b) Silage.

(c) Standing hay(foggage).

(a) Hay making

Hay refers to forage crops which have been cut and dried to about 15-20% moisture content so that they can safely be stored without undergoing fermentation and becoming mouldy. Hay can be made from pasture grass and legumes such as desmodium.

Procedure for hay making

(i) Cut the forage crop when 50% of the plants have flowered.

(ii) Dry the cut crop to about 15-20% moisture content over 2-3 days.

(iii) Gather the hay and store in a shed out of reach by rain water.

(iv) Stack the dry material into bales.

Factors affecting the quality of hay

(i) Species of forage used: Legumes usually have high crude protein hence are of higher quality than grasses.

(ii) Stage of growth at which forage is cut: Forage has maximum nutrients if harvested when 50% of the plants have flowered. Delay in harvesting leads to a lower nutrient content since the nutrients would have been used in seed setting.

(iii) Length of the drying period: Prolonged exposure leads to bleaching of nutrients and breakdown of carotene.

(iv) Leaf:Stem ratio of the forage material: The higher the ratio, the higher the quality.

(v) Degree of damage during handling and hauling: Damage may be as a result of leaf breakage, fermentation or bleaching.

(vi) Weather conditions during the drying process: If rained on, leaching of soluble nutrients is likely to occur.

(vii) Amount of foreign material such as weeds in the hay.

(b) Silage making

Silage is cut forage which is anaerobically fermented and preserved when they are green. It can be stored for a long period of time. The process of silage making is called ensiling and the structure where it is prepared is known as a silo.

Procedure of silage making

(i) Prepare a silo. The size of silo depends on the amount of forage material available.

(ii) Cut the forage at the appropriate stage of growth.

(iii) Wilt it for 6 – 12 hours depending on prevailing weather conditions to 65% – 75% moisture content.

(iv) Chop the forage into small pieces.

(v) Fill the silo, compacting after every 10 – 12 cm layer.

(vi) Fill the silo as rapidly as possible preferably within one day.

(vii) Check on the temperature regularly during the ensiling period. It should be an average of 31°C. If temperature is higher, sprinkle some water. If temperatures are low, compact it further.

(viii) Cover the ensiled material with a polythene sheet or a layer of dry grass.

(ix) Cover the silo with a thick layer of soil to form a concave appearance.
(x) Dig a trench around the silo to drain off rainwater.

Effects of too much air in silage making

(a) Over heating.
(b) Decomposition.

Therefore, too much air is undesirable in silage making.

Principles of preservation

- Aerobic respiration must be reduced as much as possible by compaction and rapid filling. This is because it utilises the available soluble carbohydrates hence lowering the quantity of nutrients in the silage.
- When the silo is covered, the oxygen supply is cut off. Aerobic respiration gradually ceases and anaerobic respiration sets in. This leads to rapid increase of *Lactobacillus spp* bacteria within the first three to four days of covering the silo.
- *Lactobacillus spp* bacteria acts on the readily available carbohydrates, producing lactic acid and trace amounts of acetic, propionic, formic and succinic acids.
- The increase in lactic acid concentration leads to a reduction in forage pH from 4.0 to 2.0 or even lower. The low pH inhibits further bacterial multiplication and growth and hence preserves the silage. This process is complete in 2 – 3 weeks. The resulting silage material may be preserved for years as long as the silo remains unopened.

Types of silos

1. Clamp silo

It is constructed above the ground level with slanting walls. The sides are made up of a pair of timber with soil put in between them. The walls can also be made of stone and the floor cemented.

2. Trench silo

This is a rectangular excavation done under the ground. Its size depends on the quantity of the material to be ensiled.

3. Bunker silo

This is often made of concrete above the ground level and has perpendicular walls which are suitable for mechanical ensiling.

Disadvantages of silage making

(i) It requires high level of skills.

(ii) It is labour intensive and expensive.

(iii) It is susceptible to loss of nutrients through seepage and volatilization.

(iv) It is bulky to store and handle.

(v) Must be fed soon after removal from the silo or else it spoils.

(vi) Grass loses original taste.

Qualities of good silage

Good silage should have the following characteristics:

(i) Be from high quality forage cut at the proper stage of growth.

(ii) Have a pH of 4.2 or below.

(iii) Have 5 to 9% lactic acid.

(iv) Be free of moulds and bad odours such as of ammonia and butyric acid.

(v) Be green to yellow in colour but not brown or black.

(vi) Have a fine texture but with no slimeness.

Factors affecting quality of silage

(i) Stage of maturity of the crop when cut for ensiling: Flowering stage is the best when the crop plants have a lot of nutrients.

(ii) Type of plant material used: For instance grass, legume or a mixture of legume and grass. Legumes have higher crude protein hence higher in nutritive value than the pasture grasses.

(iii) Moisture content of the forage crop: High moisture content lowers the quality of silage to sour. Low moisture content makes the material pack insufficient in the silo.

(iv) Addition of water, molasses and grains: This increases the palatability of the silage.

(v) Extent of compaction: This affects the temperature in silo which is crucial for the fermentation process.

(vi) Filling duration: Faster filling of a silo is best, as it minimises loss of nutrients by volatilization.

(vii) Leaf: stem ratio of the silage material used: The higher the ratio, the better

the quality as this affects the palatability of the feed.

Advantages of silage

(i) There is minimal loss of nutrients in the preserved feed. The material has a high feeding value. It is succulent and is eaten practically without any waste.

(ii) It is less dependent on weather conditions for its preparation unlike hay which requires sunshine for drying.

(iii) Once ensiled, there are no storage problems and silage can therefore be preserved for long.

(iv) Ensiling kills all weed seeds hence discouraging the spread of weeds.

Precautions when feeding silage to animals

(i) It must be fed to cows after milking in order to avoid tainting the milk.

(ii) 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.

(iii) Left-over silage must be discarded.

(iv) Silage with moulds or bad odour should be disposed off.

(c) Foggage/standing hay

This is an ungrazed forage left in the field for feeding during dry periods. It is the most common method used by farmers. Herbage quality is low due to overgrown foliage. It can only meet the maintenance ration requirements of animals and supplementary feeds should be provided.

Factors affecting quality of pasture

(i) Pasture species: Leguminous pasture are rich in crude protein than grass pasture.

(ii) Digestibility of pasture: Cultivated pasture have a higher digestibility than natural pasture. Digestibility of a pasture is depended on the stage of growth of the pasture; younger plants have a higher digestibility than very mature fibrous plants.

(iii) Ratio of legumes to grasses in pasture. The lower the ratio, the higher the digestibility and usefulness to animals. Legumes fed to animals alone causes bloat.

(iv) Ratio of leaves to stems: The higher the ratio the higher the quality.

(v) Stage of growth at which the forage is used. At the flowering stage, pastures provide the highest nutritive value.

(vi) Crude protein content of pasture: Some types of grasses and legumes have varying amounts of crude protein.

(vii) Soil fertility: Level of nutrients present in the soil determines the mineral composition of the pasture.

(viii) Toxicity level of the species: Certain fodder crops have higher levels of alkaloid chemicals which may lower the palatability of the pasture to animals.

(ix) Palatability: Some pasture species are more palatable than others.

Practical Activity 4.3

1. Plant various forage crops in the school in small plots, construct silos and conserve as silage.
2. Cut grass in the school compound and use it to make hay bales.
3. Visit pasture land and observe the pasture.

Revision Exercise 4

1 . Define the following:
   (a) Pasture.
   (b) Grass ley.

2 . State the advantages of mixed stand pasture over pure stand pasture.

3 . State the reasons why weed control in forage crops is necessary.

4 . Explain the different methods of pasture establishment.

5 . State six benefits of rotational grazing.

6 . (a) Why is it important to conserve forage?
   (b) State three methods of forage conservation.

7 . Briefly describe the process of making hay.

8 . State the precautions observed in the use of silage.

Topic 3

Animal Production

Unit 5 Beef Production

Specific objectives

By the end of this unit, you should be able to:

(a) List the breeds of cattle for beef production.

(b) Select the breeds of cattle for beef production.

(c) Describe management practices in beef production.

Introduction

Beef is the meat obtained from cattle and is one of the most popular delicacies worldwide. It is a good source of animal proteins and minerals like iron and cobalt. Malawi is not self-sufficient in the production of animal protein. There is a large demand for animal protein in both rural and urban population. Cattle population has been declining in the past decade from 750,000 in 1994 to an estimated population of 700,000 in 2003, while the human population continues to rise. This calls for adoption of better production techniques and use of the right breeds of cattle for higher yields. Beef cattle are raised for production of meat.

Beef is obtained from the following groups of cattle:

- Indigenous beef cattle breeds.
- Exotic beef cattle breeds.
- Dairy cattle culls.

Differences between indigenous cattle and exotic cattle

Exotic (*Bos taurus*)	**Indigenous** (Bos *indica*)
• Have no humps.	• Have humps which store fat.

• Adults are relatively large.	• Adults are relatively small.
• Have short and wide head.	• Long and narrow head.
• Skin is thin and tight on the body.	• Skin is thick and loose falling in folds
• Susceptible to tropical diseases.	• Tolerant to tropical diseases.
• Mature early.	• Mature late.

Exotic (*Bos taurus*)	**Indigenous** (Bos *indica*)
• Produce a lot of milk.	• Produce less milk.
• Cannot walk long distances in search of water and pasture without lowering production.	• Can walk long distances distances in search of water and pasture without lowering production.
• Have a short calving interval.	• Have a long calving interval.
• Have a long lactation period.	• Have a short lactation period.

The following diagram shows parts of a beef cattle

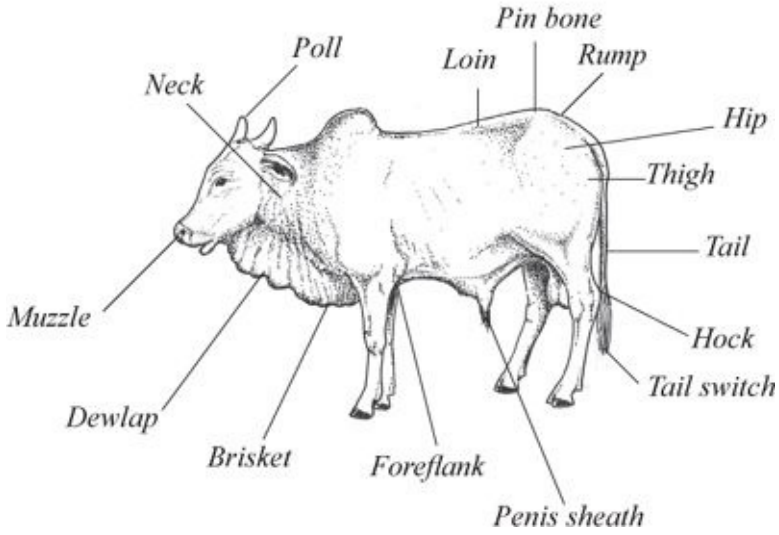


Fig. 5.1: Parts of a beef cattle .

Factors that make local cattle more adapted to the tropical climates

• Short smooth coat of hair that enables them to survive in hot areas.

- Large surface area per unit body weight is ideal for heat exchange.
- Very efficient sweat glands for good heat dissipation mechanism.
- A lower metabolic rate than *Bos taurus* hence less internal heat generation.
- Great walking ability which is ideal for walking long distances in search of water and scanty pasture.
- High heat tolerance.
- Some are fairly resistant to tropical diseases such as Trypanosomiasis and East Coast Fever (ECF).

Breeds of cattle for beef production

There are several breeds of cattle reared for beef production in Malawi. They include indigenous cattle, exotic beef breeds of cattle and dairy cattle culls.

Below is a list of breeds of cattle that can be kept for beef production and their main characteristics.

1. Malawi Zebu

This is an indigenous breed of Malawi. Currently the animal has been extensively crossed with exotic breeds as well as other local crosses.

Its characteristics are therefore varied. However, the local breed has the following charcteristics:

(a) Small body size.

(b) Slow growth rate.

(c) Long calving intervals of up to 540 days.

(d) Low milk production.

(e) Black, brown or white colour.

2. Hereford

Origin: Herefordshire in England.

Colour: Red with a white face, chest and udderline.

Size: Bulls weigh 1000 kg live weight
Cows weigh 850 kg live weight.

Other characteristics

- Are good foragers and converters of food into meat.
- Are of high fertility because bulls trail the cows on heat for long distances in

the rangelands.

- Gains live weight very fast as compared to other breeds.
- Often, the animal suffers from pink eye and the cancer of the eye because the membranes around the eyes are photosensitive.
- The females have a problem with the prolapse of the uterus.

3. Charolais

Origin: Western France

Colour: White or creamy white.

Size: Bulls weigh 1200 kg live weight.

Cows weigh 1000 kg live weight.

Other characteristics

- They are polled, but some have short horns.

4. Brahman

Is a breed of zebu cattle.

Size: Bulls weigh 800 kg – 1100 kg live weight.
At birth, calves weigh 30 – 33 kg live weight.
Cows weigh 500 kg – 700 kg live weight.

Colour: Grey or red. The tail switch is black and has black pigmentation on their noses, tips of ears and hooves.

Other characteristics

- 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 abilities.

5. Sussex

Origin: Sussex area of Britain.

Colour: Pigmented skin and uniform red colour.

Size: Medium sized.

Other characteristics

- They survive under harsh conditions due to its non-selective grazing habits and superior heat resistance.
- They are early maturing
- They are good in milk production
- High fertility.

6. Afrikander

Origin: South Africa

Colour: Deep red.

Other characteristics

- They have long spreading horns.
- They have a small hump.

7. Boran

This is the most important indigenous beef breed in Africa.

Origin: Northern Kenya/Ethiopia region.

(a) Improved Boran has the following characteristics:

(b) A broad head and muzzle.

(c) A big short neck

(d) Straight and broad back

(e) Loose skin with short fine hair.

(f) Usually white, but can also be grey or red.

(g) Average live weight: Bulls weigh 800 kg; cows weigh 450-500 kg.

(h) Short and straight horns. Others are polled.

(i) Can withstand drought and heat.

(j) Are good grazers.

8. Simmental

Origin: Switzerland.

Colour: Light red with white patches. The head is always white.

Size: Very large and heavy breed.

Other characteristics

(a) They have a fast growth rate.
(b) They are well fleshed.

9. Aberdeen angus

Origin: North Eastern Scotland in the county of Aberdeen.

Colour: Black in colour.

Size: Average live weight of bulls upto 900 kg and cows up to 750 kg.

Other characteristics

• They have a cylindrical body conformation.
• They have high beef qualities.
• Bulls do not trail cows on heat particularly where distances are great.
• They are naturally polled.

Selection of the breed for beef production

Beef cattle have the following characteristics:

(a) Blocky, square or cylindrical appearances. The top and lower lines are almost straight.
(b) Deep well fleshed bodies.
(c) Early maturity and faster growth.
(d) Deep chest and girth.
(e) Square rumps and heavy hind quarters.
(f) Tolerance to high ambient temperature.
(g) More resistance to diseases as compared to dairy breeds.
(h) High ability to convert feeds into flesh (high feed conversion ratio).
(i) Breed regularly.
(j) Short-legged.
(k) Good foragers and so are able to feed on poor pasture.

Management practices in beef production

In Malawi, beef cattle are raised under the following systems:

(a) Extensive system.
(b) Intensive system/high input production system.

(a) Extensive system

In this system, the cattle are grazed on communal grazing fields. Attendants usually lead the cattle to the dambos (marshlands which on drying develop lush good quality grass).

There are extensive beef cattle ranches where the cattle graze freely in the large farms. Examples include: Dzalanyama ranch in Lilongwe and Kuti in Salima.

(b) Intensive/high input production system

The beef cattle are kept in feedlots, stalls (khola) or grazed in paddocks. The beef animals are fattened in large scale feed lots. Majority of these farms are in Shire Valley.

The animals in stalls or feed lots are intensively fed on crop residue, agricultural by-products and towards slaughter (3 to 4 weeks) they are fed on concentrates such as maize meal and cotton seed cakes. They are also given mineral supplements and clean water *adibitum* .

The animals are rotationally grazed in paddocks to help reduce parasite attack.
Animals for fattening are sourced from open markets, own animals and males from dairy farms.

1. Housing

In stall feeding a zero grazing unit/khola is used. Calves are housed in structures called calf pens.

Types of calf pens

(i) Permanent calf pens

These are structures constructed on the ground such that they cannot be moved to new grounds.

(ii) Movable calf pens

These are structures constructed in a way that they can be moved from one place to another. Movable pens are the most ideal in the rotational grazing method of livestock rearing.

For the first two months, the calf should be kept in an individual pen measuring 1 m × 1.5 m. It is important to house calves singly in order to prevent cross-suckling. This is where calves suck or lick each other, swallowing hair, which form balls in the stomach leading to digestion discomfort and may cause death.

A good calf pen should be:

- Draught-free; ensure there is no or minimal entry of winds and have leak-proof roof.
- Well drained, preferably with a raised slated floor.
- Well lit; the front wall of the calf pen should be constructed a solid 60 - 90 cm high, while the rest of the space is covered with a wire mesh. This is important to allow animals to access sunlight necessary for the synthesis of vitamin D.
- Spacious; adequate spacing facilitates easy cleaning of the pen and enables the calf to move about, feed and exercise.
- Well ventilated; this is for proper air circulation, to reduce dampness and to regulate temperature in the calf pen.

Zero grazing unit

This is a structure for housing livestock in total confinement. The animal is fed in the unit and is rarely moved out. The zero-grazing unit comprises of a feeding area, sleeping area, feed store, calf pen, feed preparation section and dunging area. The floor is preferrably made of concrete for ease of cleaning while the walls can be made of timber, bricks, stones, meshed wire, metal columns, pipes or iron sheets. All sections of the unit are roofed except the resting area where the animal does exercises and gets sunshine. Roofing material may be iron sheets or grass.

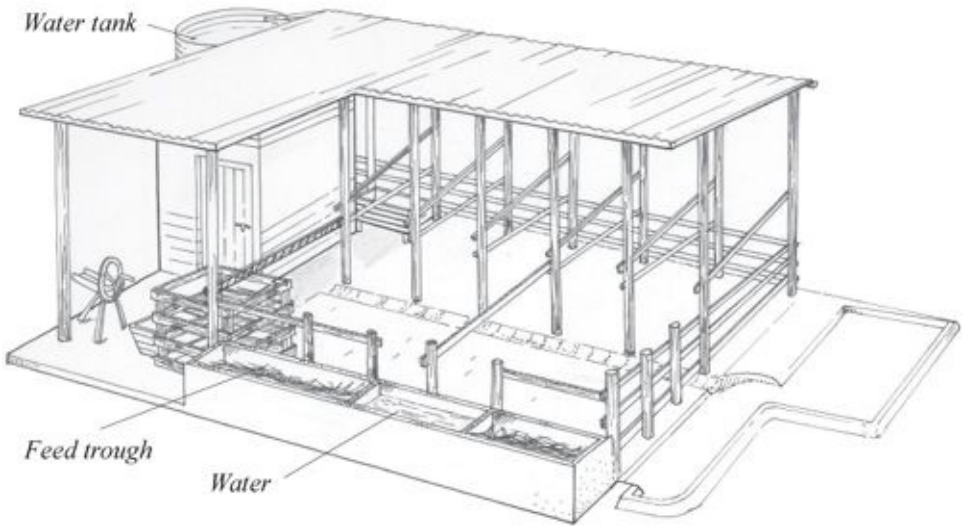


Fig. 5.2: Zero-grazing unit .

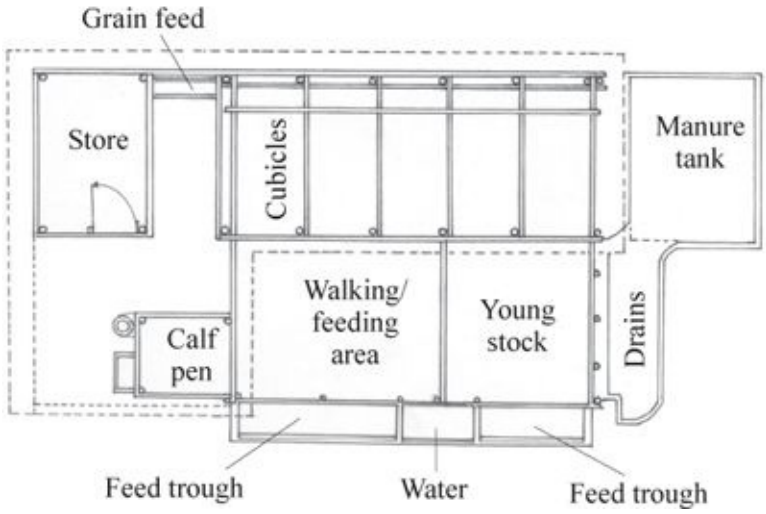


Fig. 5.3: Ground plan of the zero-grazing unit .

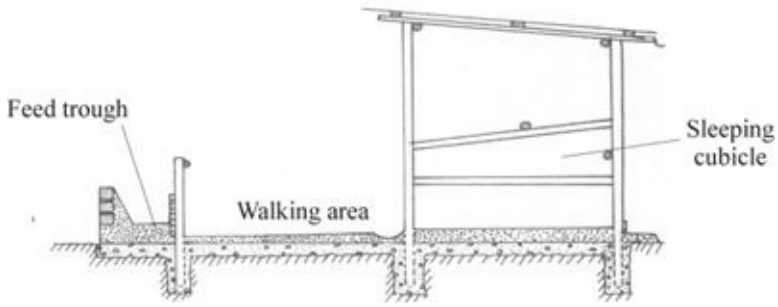


Fig. 5.4: Side plan of a zero-grazing unit .

Practical Activity 5.1

Visit a beef cattle farm and observe the type of housing structures used.

2. Feeding

A newly born calf is fed on colostrum during the first 4 – 5 days after parturition. Colostrum is the first thick yellow milk produced by a cow after parturition.

Colostrum must be taken by a calf within the first eight hours after birth. This is because certain macro-molecules in the colostrum deteriorate with time lowering its quality.

Importance of colostrum to the new born calf

(i) It is highly nutritious that is, it is rich in proteins, vitamin A, vitamin D,

vitamin E, minerals and fats.

(ii) It is highly digestible hence it is suitable for the newborns whose digestive systems are not fully developed to handle solid feeds.

(iii) It is rich in antibodies which pass immunity from the mother to the calf.

(iv) It has laxative effect which clears the first faeces (faecal meconium) from the digestive system.

In beef cattle management the calves suck their mothers directly. They graze with them in the fields. The calves later learn to graze like their mothers. The calves should be provided with quality pasture such as young lush grass as they begin to learn to eat grass. They should also be provided with plenty of clean water. The weaners should be fed on natural grass or crop residues until 3 to 4 weeks prior to slaughter. At this time, they are fed liberally on concentrates such as bran (*Madeya*) sunflower cakes, maize germ meal and mineral licks so as to attain slaughter weight easily.

Practical Activity 5.2

Visit a zero grazing unit and observe how animals are fed.

3. Parasite and disease control

Parasites are organisms which derive part or all their nourishment from other organisms known as hosts. The host-parasite relationship benefits the parasite but it is harmful to the host.

Classification of parasites

Parasites are grouped into two classes depending on where they live in or on the host:

(a) External parasites (Ectoparasites); they feed on the host externally that is, outside the body. They include mites and insects such as, tsetse flies, lice and ticks.

(b) Internal parasites (Endoparasites); They live inside the body of the host. Included in this group are worms, such as tapeworms and liver flukes.

External parasites

External parasites or ectoparasites are usually found on or under the skin of the

hosts body. Examples are lice, ticks, mites and tsetse flies.

Signs of infestation by external parasites

(i) Presence of parasite or eggs on, or under the skin of the animal's body.
(ii) Irritation of the skin.
(iii) Loss of hair, fur, feathers and wool.
(iv) Sores or wounds on the skin.
(v) Emaciation.

Effects caused by external parasites

(i) Anaemia due to sucking of blood by the parasites such as ticks.
(ii) Protozoan diseases such as East Coast Fever and trypanosomiasis.
(iii) Death of host under heavy infestation.

Ticks

Ticks are common external livestock parasites responsible for the transmission of a number of serious livestock diseases. They also cause anaemia and damage the skin as a result of their bites.

Fig. 5.5: A tick

Types of ticks

There are two types of ticks:
(i) Soft ticks (*Argasidae*); they have a tough leathery outer coating.
(ii) Hard ticks (*Ixodidae*); they have a hard, shield-like covering at the upper surface in males. The females have a small area behind the head.
Hard ticks are more harmful to their hosts than soft ticks. Soft ticks undergo several nymph stages in their life cycle, whereas hard ticks go through only one nymphal stage in their life cycle.

The life cycle of hard ticks

There are four stages in the life cycle of hard ticks.

The egg

Eggs are laid by the female tick in the cracks on the ground, or under the bark of trees. They hatch into larvae within 4–6 weeks under favourable (warm and moist) conditions.

The larva (six- legged)

The larva climb onto grass blades in clusters and attach themselves to the host animal. After 3–5 days of feeding, they become engorged that is, fully-fed following which they, either drop off the host to the ground, or moult on the body of the host into eight-legged nymphs.

The nymph (eight- legged)

Nymphae emerge from the ground and climb up grass stems in search of hosts. If moulting took place on the body of the first host, nymphae continue to feed on it. Upon attachment to the second host, the nymphae look for feeding sites, then suck blood to full engorgement. Once fully engorged, the nymphae either drop off and moult on the ground, or remain attached to the host. Adult ticks emerge from the nymphal moulting.

The adult tick

The adult ticks attach themselves to grass awaiting passing-by animals. If moulting occured on the body of the host, the ticks continue feeding on the host at new feeding sites. Males and females mate on the host. After sucking blood to full engorgement, the female ticks drop off to the ground and lay eggs, after which the cycle is repeated.

Categories of hard ticks

Hard ticks are divided into three categories depending on their reproductive habits or life cycle.

(a) One-host ticks

These are ticks which need only one host to complete all the stages in the life-cycle, that is, they remain on the same host from the time they attach themselves as larvae until they drop off as fully-fed adults. They are the most common type of ticks in Africa and are the most resistant to acaricides. Examples of one - host ticks are:

(a) The blue tick - *Boophilus decoloratus* .

(b) The cattle tick - *Boophilus microplus* .

The life cycle of one - host ticks

The eggs on the ground hatch into larvae which then attaches onto a host. The larvae suck blood for 3-5 days and then moult into a nymph. The nymphae in turn, feed on the host for 4-6 days until they are fully engorged. They then moult into adult ticks. The adults mate on the host animal and upon engorgement, the females drops on the ground and lay eggs and the life cycle continues.

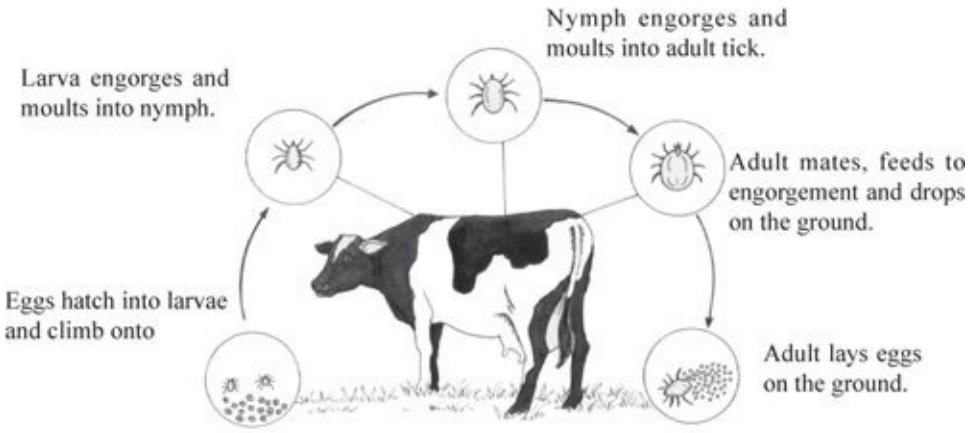


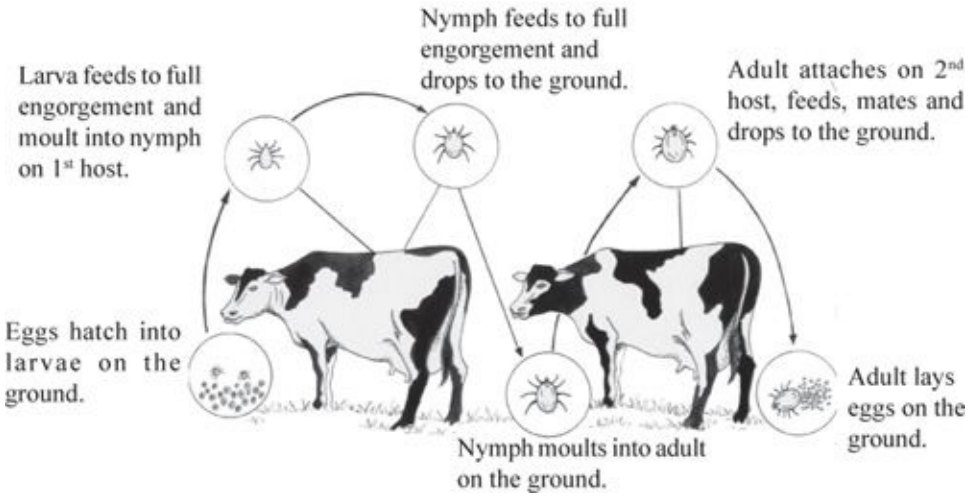
Fig 5.6: Life cycle of a one-host tick .

(b) Two-host ticks

These are ticks which need two hosts in order to complete their life cycle. They spend their first moulting stage from larvae to nymphae on one host, but the second moulting stage from nymph to the adult takes place on the ground. The adult which emerges from nymph moulting attaches itself to a second host, feeds to full engorgement, then drops to the ground to lay eggs. The complete life cycle can last longer than two months.

The main ticks in this category are the red-legged tick (*Rhipicephalus evertsi*) and the brown tick (*Rhipicephalus bursa*). During the larval and nymphal stages, the red-legged ticks feed on the deep inner grooves of the ears of cattle, while adults feed around the anus and vulva region, and under the tail. The tick transmits red water disease in cattle.

The bont-legged ticks (*Hyalomma spp* .) usually feed as larvae and nymphae on small mammals. As adults, they feed on cattle and other large animals where they can be found on the udder, scrotum, tail and on the feet. They transmit the sweating sickness in cattle.



5.7: Life cycle of a two-host tick

(c) Three-host ticks

These ticks need three different hosts in order to complete their life cycles. Most hard ticks of economic importance belong to this category. They undergo both moulting stages on the ground. One animal can play the role of all the three hosts. The life cycle lasts upto two years.

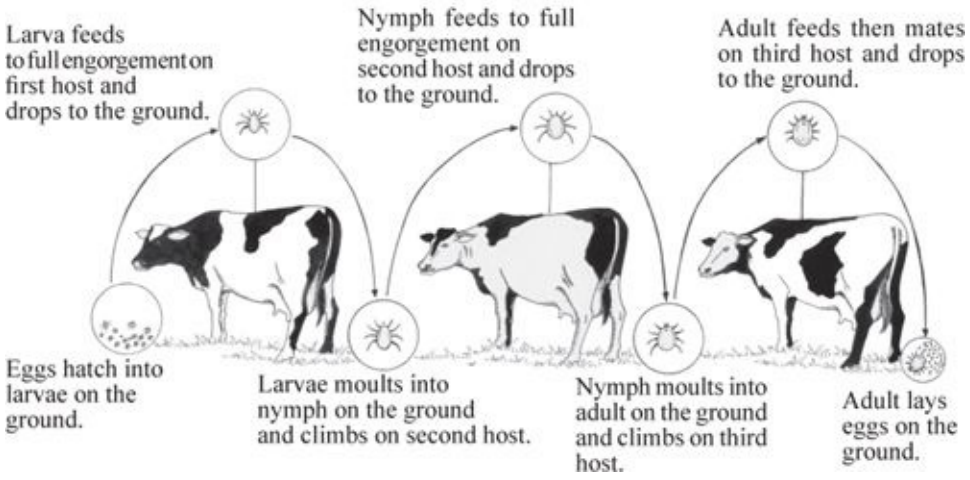


Fig 5.8: Life cycle of three-host tick

The main ticks belonging to this category are the, Brown ear tick (*Rhipicephalus appendiculatus*), and the Bont-tick (*Amblyomma* spp.). Brown ear tick larva and nymph can be found on the face and muzzle of cattle while the adult ticks can be found located on the inner grooves of the ear. They are known to transmit East Coast Fever in cattle and Texas Fever in sheep.

Bont ticks are large in size and inflict deep wounds. The larvae and nymphae

usually feed on the groin, scrotum, udder, and the tail brush of cattle. They transmit heartwater disease in cattle, sheep and goats.

Tick control

There are several measures used to control ticks:

(a) Chemical dipping and spraying

The chemicals used to kill ticks are known as **acaricides.** Tick control can be achieved by the application of acaricides once or twice a week depending on the level of tick infestation. In order for the acaricide to give effective results, the dilution must be done according to the manufacturer's instructions. Do not over-dilute, dipwash or spraywash. At the same time, the concentration should not be too high as it risks poisoning the animals.

Methods of acaricide application include dipping, hand spraying and handdressing. The acaricide used must be of the correct strength and be applied to all body parts.

> Hand-dressing involves the application of acaricide by hand where spraywash may not reach that is, in the inner grooves of ears by use of pyegrease.

(b) Fencing

Tick control can be effectively practised where a farm is enclosed by a fence. Fences restrict movement of animals thus minimising the spread of ticks. Double fencing and use of zero grazing units ensure effective tick control.

(c) Rotational grazing

Rotational grazing reduces the build-up of ticks in pasture.

(d) Burning of infested pasture

Adult ticks, their eggs, moulting larvae and the nymphs can be destroyed by burning infested pasture. This method is mostly used in range lands.

(e) Ploughing the land

This buries ticks deeply on the ground thus rendering them unable to live.

Tsetse flies

Tsetse flies are blood-sucking insects which attack human beings and livestock such as, cattle, sheep and horses. They mainly inhabit humid, bushy areas and can be found under certain shade trees. Tsetse flies become active during the day (especially in the morning and evening) and attack by inflicting painful bites on animal. Tsetse flies (*Glossina spp* .) transmit trypanosomiasis (nagana) in livestock.

Areas heavily infested with tsetse flies are unsuitable for human settlement and livestock keeping.

The following measures are used to control tsetse flies:

(a) Clearing bushes in areas infested by tsetse flies.

(b) Spraying the infested vegetation with appropriate insecticides.

(c) Sterilisation of the male tsetse flies by use of chemicals.

(d) Trapping of the flies using special nets treated with appropriate chemicals. The chemicals are usually laced with insect-attracting pheromones.

(e) Creating buffer zones near Game Reserves thereby preventing the transmission of infection from wild animals to livestock.

Fig. 5.9: Tsetse fly (*Glossina spp* .)

Internal parasites

The internal parasites are also referred to as endoparasites.

Endoparasite worms (*Helminths*) can be divided into:

Flat worms (*Platyhelminthes*) such as flukes.

Roundworms (*Nemathelminthes*).

Flat worms

The flat worms can be grouped into:

(i) *Trematodes:* These are flat worms with flattened dorso-ventral bodies that is, the back and belly are close together. *Trematodes* are mostly hermaphrodites, that is, they possess both male and female reproductive

organs. An example is a tapeworm.

(ii) *Cestodes:* This group of flatworms have body sections with complete reproductive organs, with one nervous and excretory system running continuously through the body. The head part attaches the worm to the host of the body by means of hooks or suckers. The separate sections bud off one - by - one, making a long chain. Those sections farthest from the head are the oldest buds such as tapeworms.

The liver fluke (*Fasciola spp* .)

Liver flukes mainly attack cattle and sheep causing a disease called *fasciolasis* or *distomatosis* which results in weight loss in the affected animals. Flukes inhabit bile duct of the animal host and cause damage to the liver. Liverflukes are prevalent in low-lying, wet marshy lands or areas prone to flooding. The most important species of the liverfluke are *Fasciola hepatica* and *Fasciola gigantica* .

Fasciola hepatica is grey or grey-pink in colour with a conical projection at the anterior end and a tapering body to the posterior. It has two suckers, one in the centre of the conical projection and the other on the ventral surface close to the conical projection.

Symptoms of attack

(i) Digestive upsets due to blocking of bile duct.

(ii) Swollen abdomen.

(iii) Emaciation and in extreme cases, recumbency leading to death.

(iv) Anaemia occurs as a result of the destruction of liver tissues.

(v) Oedema in the jaws (swollen lower jaw).

Control measures

(i) Routine drenching by use of appropriate drugs such as antihelminthic drugs.

(ii) Destroying water snails by treating swampy water with copper sulphate.

(iii) Fencing off heavily infested swampy areas to prevent farm animals from grazing in such infested areas.

(iv) Draining swampy areas within the farm.

Life cycle of liver flukes

The eggs which enter the bile duct are carried into the intestines and passed out in faeces. In moderately warm temperature, the eggs hatch in water to produce

the first larval stage called the **miracidium** (in about 9 days).

The miracidia swim in the water by means of cillia which cover the body. On coming in contact with the water snail which is the intermediate host, they penetrate into its body. In the water snail, they develop into **sporocysts.** These reproduce asexually and multiply into **radiae.** These later develop into a larval stage called **cercarium** and further into the **metacercarium** which is the encysted infective stage.

Mature metacercariae leave the snail and attach themselves onto grass. They enter the definite (primary) host by ingestion when animals graze on infested pasture or drink contaminated water. Inside the body of the primary host, the metacercariae hatch into adult form, penetrate the intestinal wall and inhabits the liver where they develop for a period of 5 - 6 weeks. They then enter the bile duct and become sexually mature. The cycle takes about 6 - 7 weeks.

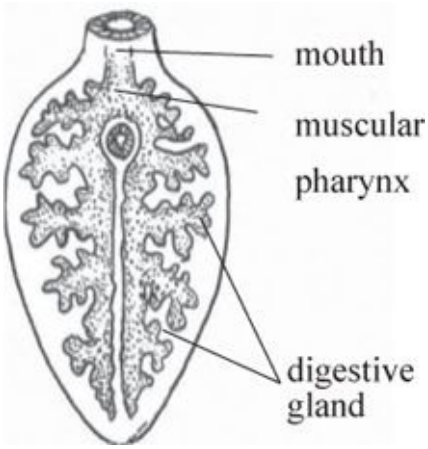


Fig. 5.10(a): Parts of a liver fluke

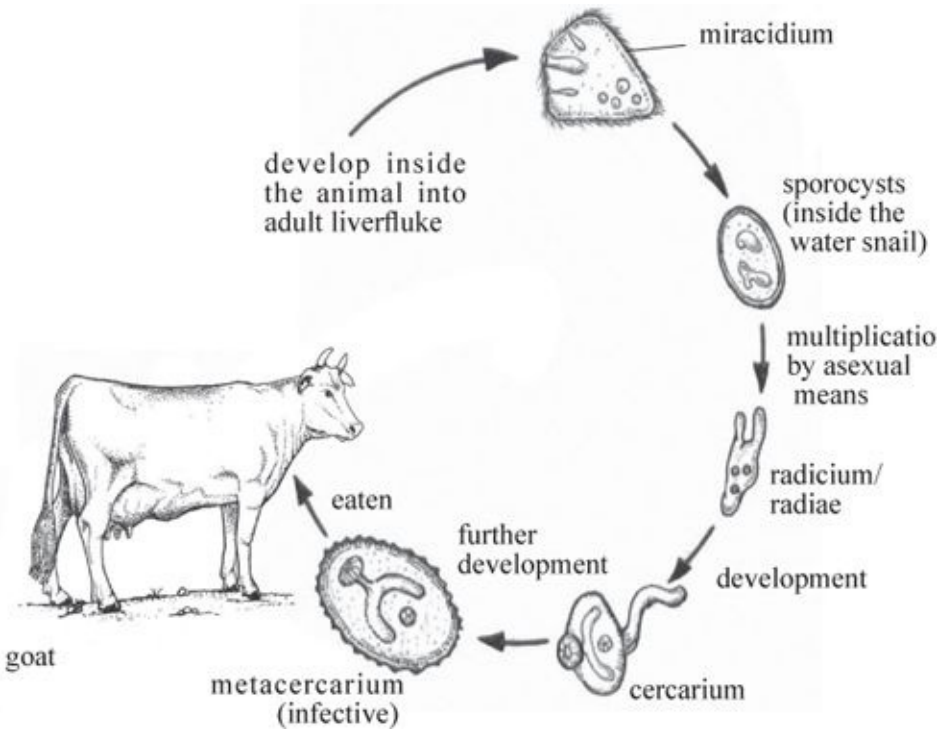


Fig. 5.10(b): The life cycle of liver fluke, Fasciola hepatica .

Tapeworms *(Taenia spp)*

A tapeworm consists of a head **(scolex)** and a chain of body segments referred to as **strobila.** Each segment is called a proglottid. The scolex possesses suckers and hooks for attachment onto the host. The proglottids have a common nervous system and a rudimentary excretory system. Each proglottid has its own male and female sex organs. Tapeworms affect human beings as well as livestock such as cattle, sheep, goats, and pigs. The two most common tapeworm species that affect livestock are: *Taenia saginata* and *Taenia solium* . Tapeworms *(Taenia spp.)* are host-specific, such that, *Taenia saginata* (the beef tapeworm) affects cattle only whereas, *Taenia solium* (the pork tapeworm) only affects pigs.

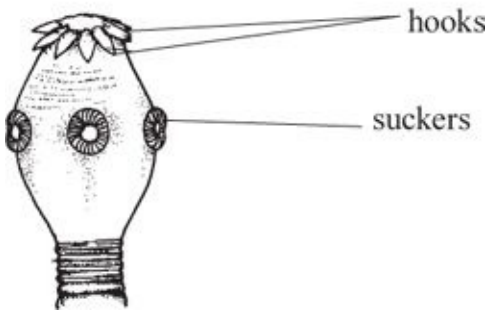


Fig. 5.11: Head (scolex) of pork tapeworm .

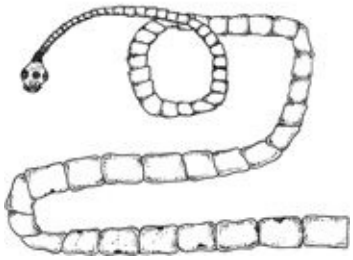


Fig. 5.12: Strobila .

Life cycle of beef tapeworms *(Taenia saginata)*

The life cycle of tapeworms starts with the passing out of eggs in the faeces. The eggs are usually passed out while still intact in the proglottids which break off from the rest of the strobila. The proglottids degenerate on the grass, leaving the uterus to remain as a sac containing the embryonated eggs. The sac bursts open releasing the eggs, which are eaten by the intermediate host, the cow.

Within every egg an embryo known as the **oncosphere,** develops transforming into a bladderworm. The bladderworm hides within the muscle tissue of the animal. Sometimes the bladderworm buds off giving rise to many bladderworms. The hidden bladderworms remain within the muscles of the intermediate host. When the intermediate host is slaughtered and its meat consumed raw or undercooked by man (the primary host), the bladderworms become active. They attach themselves to the intestine walls, feed and develop into adult tapeworms.

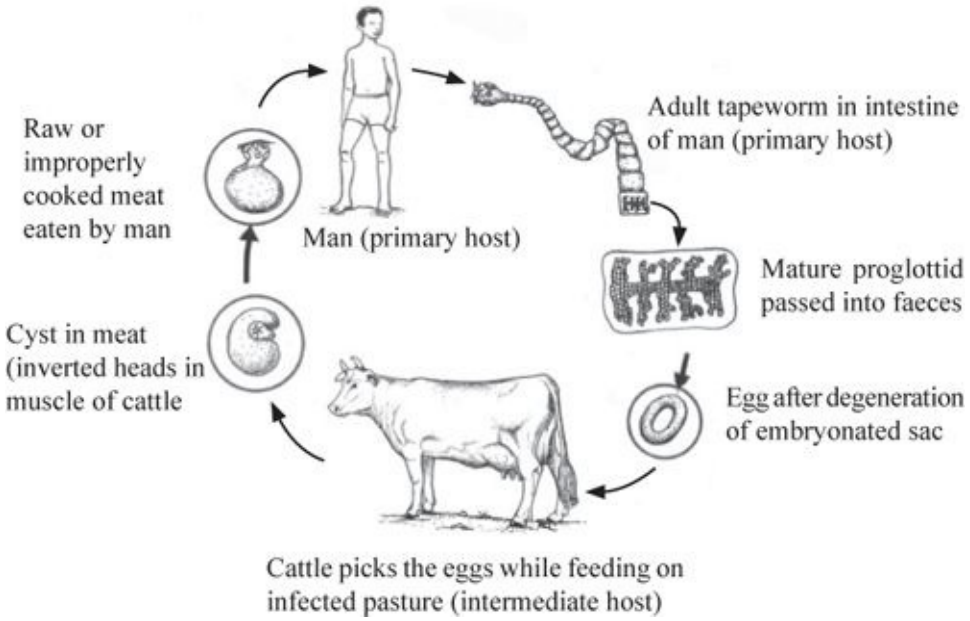


Fig. 5.12: Life cycle of beef tapeworm (Taenia saginata)

Signs/symptoms of tapeworm attack

(i) Rough hair coat.

(ii) Digestive disturbances such as diarrhoea and occasional constipation.

(iii) Pot belly.

(iv) Anaemia (lack of blood).

(v) Oedema.

(vi) Egg segments or proglottids in the faeces.

Control measures

(i) Routinely deworm animals using appropriate drugs, such as nilzan, albendazole and mebendazole.

(ii) Plough the pasture land to kill the cysts.

(iii) Proper disposal of human waste such as the proper use of latrines.

(iv) Proper cooking of meat.

(v) Proper meat inspection.

Roundworms *(Ascaris spp.)*

These are usually cylindrical in shape and pink/white in colour. They exist as male and female. Roundworms inhabit the alimentary canal of livestock. Livestock affected include cattle, sheep, goats and pigs.

The common species of roundworm are *Ascaris lumbricoides* (affect cattle and sheep), *Ascaris suum* (attack pigs) and *Ascaris galli* (affect poultry).

Life cycle of roundworms

The roundworm may exhibit two different life cycles that is, direct or indirect.

(a) In the direct life cycle, eggs hatch into larvae which are free-living, enter the host through food or penetrate through the skin.

(b) In the indirect life cycle of *Ascaris spp* . the infection may occur through any of the following ways:

(i) The eggs hatch into larvae in the open ground which are then picked by an intermediate host. When the primary host feeds on this intermediate host, they get infected.

(ii) Larvae from hatched eggs penetrate through the skin of an animal and develop within the intermediate host. Blood-sucking animals then ingest them (they act as carriers or vectors) during the feeding and the

larvae continue to develop inside the carrier. These vectors will transmit the larvae to the primary hosts when they bite them. The larvae then develop inside the primary host to maturity.

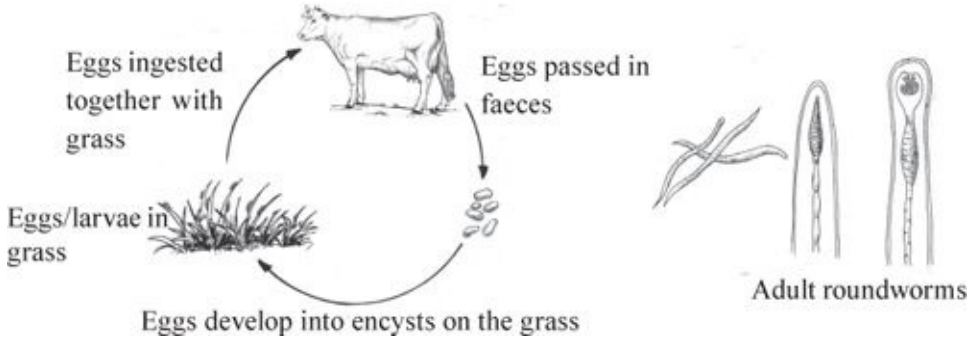


Fig. 5.13: Life cycle of roundworms (Ascaris lumbricoides) .

Life cycle of *Ascaris lumbricoides*

Eggs laid in the intestines of primary host are passed out in faeces. On the ground, they hatch into infective larvae. This infective stage is called **encyst** and is resistant to adverse environmental conditions. The **encysts** are found on grass from where they are picked (ingested) by a grazing animal. They then bore through the intestinal walls into the blood stream and are then carried by the circulating blood into the heart or lungs where they penetrate into the trachea. They are then coughed out into the mouth or reswallowed.

In the intestines, they develop into adult worms and start another cycle. Male and female worms mate and upon fertilisation, the females lay eggs.

Signs and symptoms of roundworm attack

(a) Retarded growth.

(b) Scours.

(c) Anaemia.

(d) Pot belly appearance.

Control measures of roundworms

(a) Avoid grazing animals on muddy grounds.

(b) Avoid grazing animals on wet grass early in the morning when the larvae are active.

(c) Deworm the animals using appropriate drugs.

Livestock diseases

Diseases cause serious losses in beef cattle management and farmers should endevour to control them. The following are some of the common diseases which affect cattle in Malawi.

(a) East Coast Fever (ECF)

Animals attacked

The disease only attacks cattle especially the exotic breeds. Indigenous breeds are more resistant to the disease.

Cause

The disease is caused by a protozoan *Theileria parva* which is transmitted by the brown ear tick *(Rhipicephalus appendiculatus)* . These ticks are usually found in areas of high rainfall hence the disease is rare in range lands.

Incubation period is about 10 – 25 days.

Symptoms of East Coast Feaver

(i) High fever, about 41°C.

(ii) Swollen lymph nodes which appear around the ear then spread to other parts of the body.

(iii) Difficulty in breathing in the late stages of the disease.

(iv) Nasal discharge and characteristic cough due to oedema in the lungs.

(v) The animal isolates itself from the others.

(vi) Rough coat.

(vii) Lachrimation.

(viii) Anaemic conditions occur.

Control measures

(a) Tick control measures should be carried out regularly for example, regular spraying or dipping using appropriate acaricides.

(b) Fencing of the farm to keep away stray animals.

Treatment

Use appropriate drugs such as Butalex and Clexon.

(b) Anaplasmosis/Gall sickness

This disease mainly attacks cattle and sometimes sheep and goats.

Cause

The disease is caused by the protozoa *Anaplasma marginale, Anaplasma ovis* and *Anaplasma centrale* which are transmitted by the blue tick (*Boophilus decoloratus*). It can also be transmitted from mother to young one or by biting insects such as mosquitoes, flies and mechanically through contaminated surgical instruments.

Incubation period is between 10 – 100 days.

Symptoms

(i) Animal develops fever that is, a rise in body temperature.

(ii) The animal develops constipation or releases hard dung.

(iii) Mucous membranes become pale and in some cases jaundiced due to anaemia.

(iv) Fast breathing and fast heart beat.

(v) No rumen movement that is, no chewing of cud.

(vi) The animal produces yellow urine.

Control measures

(a) Tick control measures for instance, dipping or spraying of the animal.

(b) Control biting insects.

(c) Using clean surgical instruments when carrying out operations such as castration.

Treatment

Intramascular injection of antibiotics and iron injections like iron dextran.

(c) Trypanosomiasis/Nagana

This disease affects cattle, sheep, goats, dogs, pigs and horses. In cattle, it is also referred to as *nagana* .

Cause

Nagana is caused by a protozoan of *Trypanosoma spp* . transmitted by tse-tse flies. It can also be transmitted by other biting insects and contaminated

syringes. The common *Trypanosomes* which cause trypanosomiasis are *Trypanosoma vivax, Trypanosoma congolense* and *Trypanosoma brucei* . This disease is common in the tropical climates which provide warm humid conditions favourable for the breeding of tsetse flies.

Incubation period is 1 - 3 weeks.

Symptoms

(i) Staring coat.

(ii) Enlargement of superficial lymph nodes.

(iii) Chronic loss of body condition in that the animal loses appetite.

(iv) Animal is exhausted and very weak.

(v) Anaemic conditions occur with a tendency of the animal to lick and eat soil.

(vi) Lachrimation (inflammation) of cornea which may lead to blindness.

(vii) Loss of hair at the tail switch.

(viii) Belly region becomes swollen.

(ix) Fast breathing.

(x) Intermittent fever.

Control measures

(i) Effective control of tsetse fly which acts as a disease-transmitting vector.

(ii) Confinement of game animals in game parks as these act as alternate hosts for the disease vectors.

(iii) Breeding trypano-resistant animals.

Treatment

Use appropriate drugs such as Novidium, Berenil, Evidium or any other trypanocidals.

(d) Rinderpest

The disease affects cattle, sheep, goats, pigs and wild ruminants. It is a highly infectious and contagious disease. It is classified as a notifiable disease.

Cause

It is caused by a virus known as *Paramyxo virus* . The virus can be transmitted by direct contact, discharges on beddings or containers, ingestion or inhalation. The virus is present in urine, faeces and body fluids of affected animal. Animals

that are less than one year old are immune to the disease.
The incubation period is 3-9 days.

Symptoms

(i) Rapid rise in body temperature.
(ii) Mucous membranes of the mouth and nose become red-hot and painful.
(iii) Dry and cracked muzzle.
(iv) Smelly ulcers develop in the mouth and nose.
(v) Laboured breathing and persistent cough.
(vi) Profuse diarrhoea.
(vii) Eye and nasal discharge.
(viii) Animals grind their teeth.
(ix) Staring coat.
(x) Death in 2-10 days.

Control measures

(i) Imposition of quarantine in cases of outbreak.
(ii) Vaccination of all animals that are more than one year old. This should be done annually. The immunity may last 3 – 7 years and in some cases for a lifetime.
(iii) Kill all the infected animals and dispose off their carcasses properly.
(iv) Disinfect animal houses.
(v) Isolate the sick animals.

Treatment

Nurse the animal by giving antibiotics, fluids and electrolytes.

(e) Foot and mouth disease

This disease affects cattle, pigs, sheep and goats. It is highly contagious and infectious. It is categorised as a notifiable disease. The disease mainly affects exotic breeds of animals as indigenous cattle have some tolerance to it.

Cause

It caused by *Enterovirus* . There are several strains of the virus such as “A”, “O” and “C”. The virus can be found in milk, semen, blood, saliva, nasal and oral discharges of the affected animal. The virus can be transmitted through

contaminated litter, machinery, garbage, feet and syringes. It can also be transmitted via aerosols where it may be blown by wind up to 50 km away.

Incubation period is 2 – 7 days.

Symptoms

(i) High fever which lasts for only a few hours.

(ii) Profuse and continuous salivation.

(iii) Vesicles (blisters) form in the mouth, muzzle, teats, udder, coronet and between the hooves which later open leaving wounds.

(iv) Kicking of feet.

(v) Lameness due to vesicle formation in the interdigital space and coronet.

(vi) Inflammation of tongue, lips and gums making it difficult for the animals to eat.

(vii) Great reduction in milk production.

Control measures

(i) Imposition of quarantine in cases of outbreaks.

(ii) Vaccinating the animals every six months.

(iii) Disinfect the animals' hooves.

(iv) Slaughter, burn and bury infected animals.

Treatment

Nurse the animal by giving it antibiotics, multivitamins, fluids and electrolytes.

(f) Black quarter

It is also referred to as black leg. The disease affects cattle, sheep, goats and human beings. Incubation period is 1 to 5 days.

Cause

It is caused by a bacterium called *Clostridium chauvei* . It attacks young cattle 6-24 months old. In sheep, infection may occur after shearing, docking, castration and crutching if wounds are inflicted on the animal.

Symptoms of black quarter

(i) Rise in body temperature.

(ii) Gas filled swellings of heavy muscles of neck and legs.

(iii) Grunting and grinding of teeth by the animal.

(iv) Acute lameness of the hind legs.

(v) Loss of appetite.

(vi) Death within 12 – 48 hours.

(vii) Black meat which has a sweet smell in the hind legs if examined after death.

(viii) Animal stops chewing cud.

(ix) There is blood stained exudate from the anus and nose with characteristic smell of rancid butter.

Control measures

(i) Regular vaccination of young stock preferrably at six months interval until they are 2 – 2½ years and thereafter once annually. Use blanthrax vaccine.

(ii) Restrict livestock movement that is, quarantine.

(iii) Do not open the carcass of animals that have died of this disease. Instead, properly dispose of the carcass by completely burning or deeply burying the carcass at more than 2 metres deep and sprinkle with quick lime.

Treatment

Treat with antibiotics such as Penicillin, Tetracycline, Chlorotetracycline and Oxytetracycline.

(g) Tuberculosis

This is a notifiable disease that infects the lungs but may spread to other tissues.

Cause

It is caused by a bacterium *Mycobacterium bovis* .

Transmission

Inhalation of droplets containing the bacteria in adult cattle and can also be taken with contaminated milk in young calves.

Symptoms

(i) Respiratory problems.

(ii) Coughing

(iii) Swellings of lymph nodes at the junction of the neck and head around the throat.

(iv) The animal appears dull and loses appetite.

Control

(i) Carry out quarantine measures.

(ii) Slaughter and properly dispose off the infected stock.

(h) Lumpy skin disease

This is an acute infectious disease of cattle of all ages.

Cause

Lumpy skin disease virus

Transmission

Bites of mosquitoes and flies

Symptoms

(i) Fever.

(ii) Characteristics skin nodules or skin lumps (sitfast) covering the whole body or restricted to head, neck, perineum, udder, genitalia and limbs.

(iii) Emaciation.

(iv) Milk production ceases.

(v) Low mortality

Control

(i) Vaccination.

(ii) Quarantine.

(iii) Vector control

Treatment

(i) Animals generally recover with good nursing care.

(ii) Antibiotics for secondary infections are administered.

Methods of controling parasites and diseases

The effective control of diseases and parasites is essential if livestock production is to be profitable. Diseases and parasites are a threat to livestock production. An outbreak of a serious disease may cause death to very many animals resulting in

a big loss to the farmer. Thus, it is important to take necessary measures to prevent disease and parasite infestation. Some of the disease and parasite control practices include; vaccination, deworming, hoof trimming, docking, dipping or spraying and dusting.

(a) Vaccination

Vaccination is the administration of vaccine into an animal's body to confer to its immunity against a particular disease. A vaccine is a chemical preparation of dead, weakened or altered disease-causing agents or pathogens. The process involved is called attenuation.

It is preventive treatment usually used for highly infectious and contagious diseases. It is administered by:

- Intramuscular injection directly into a major muscle mass.
- Orally; through the mouth.
- Intravenous injection; into lumen of a blood vessel.
- Subcutaneous injection; beneath skin but on top of muscle layer.
- Inhalation.

When a vaccine is injected into the body of an animal, it causes the production of antibodies which help combat *disease-causing organisms (pathogens)* . The pathogens in the vaccine are incapable of causing disease but induce the animal's body to produce a lot of antibodies which will guard the body against any invasion by the pathogen. Vaccines are specific, that is, a vaccine is developed for a particular disease causing organism. However, some vaccines may control more than one disease. Blanthrax vaccine, for example, is used to vaccinate animals against black quarter and anthrax.

Vaccines are mainly used against viral diseases such as rinderpest, Newcastle disease and rabies. Bacterial diseases vaccinated against include anthrax, black quarter, brucellosis, fowl typhoid and tetanus.

If a disease is prevalent in an area, routine vaccination can be done or vaccination carried out at the time of an outbreak.

(b) Deworming

This is the administration of drugs to livestock to control internal parasites (endoparasite) infestation. Deworming is carried out by either dosing or drenching. Most animals should be drenched once in every 3-6 months at the onset of rains because most endoparasites take 3 months to complete their life cycle. Young animals are dewormed early when infestation is noticed or at

weaning time. Early infestation of internal parasites in the young animals may also be prevented by dosing gestating mothers.

Deworming is done by use of drenching gun, dosing gun or long-necked bottle using a broad spectrum dewormer. This is one which controls a wide variety of internal parasites for example, nilzan plus.

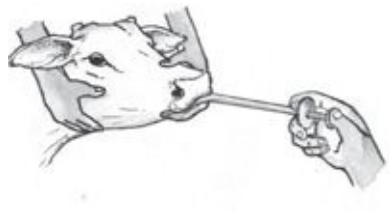


Fig. 5.14: Dosing or deworming a calf .

Procedure of administering a liquid dewormer

- Restrain the animal.
- Hold it by the nostrils and lift up its head.
- Open the animal's mouth.
- Place the drenching gun or bottle on the tongue.
- Release the drug into the mouth as far back as possible.
- Release the animal.

(c) Dipping

This is largely done for cattle to control external parasites (ectoparasites). Animals are dipped either once a week or every fortnight. Dip wash is suitable since the animals get completely immersed and thoroughly wetted.

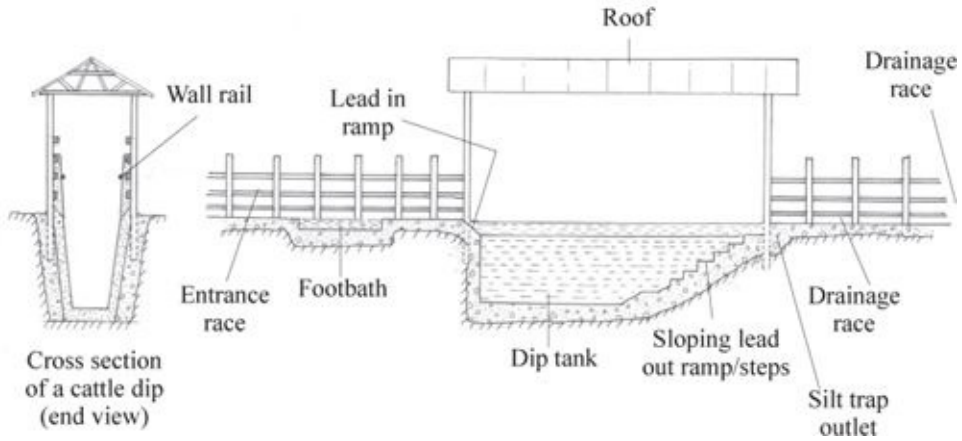


Fig. 5.15: A plunge dip

Spraying is carried out by use of a spray race or hand spray.

Advantages of using a plunge dip

- Many animals can be dipped in a single operation.
- Because of the replenishment of the bath, it can be used several times.
- The cost of dipping is low due to less wastage.
- Requires less technical skills and labour than using a spray race.
- Every part of the animal is reached by the solution due to total immersion of the animal's body.

Disadvantages

- There is risk of excessive dilution of the dip wash due to evaporation during the dry season by rain water or by impurities introduced by the animal or through leakage at the bottom or cracks at the sides.
- It cannot be used on sick, heavy, young and pregnant animals.
- The spread of viral diseases such as foot and mouth is possible through dipping of infected animals.
- It is cumbersome to replenish or empty the dip tank.
- There is a high initial cost of construction hence individual farmers cannot afford it.
- Maintenance costs may be high due to repairs of the cracks and purchase of repair materials.

(i) Use of a spray race

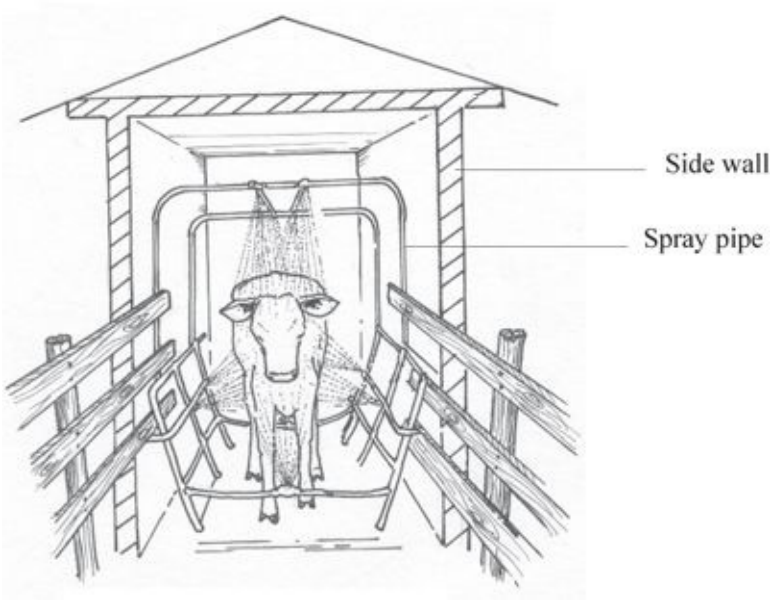


Fig. 5.16: Spraying cattle using a spray race .

The spray wash comes out under high pressure through pipe nozzles which spray the animal as it passes through the spray race.

Advantages of using a spray race

- It is faster and can spray more animals per hour than a plunge dip. This is because animals just walk through the spray race.
- Suitable for pregnant, heavy, young, goat, sheep and sick animals as they do not get shock.
- Fresh wash is used every spraying time.
- It is economical.
- It is less laborious.
- There is no poisoning of animals due to swallowing of the acaricide wash.

Disadvantages

- It requires high technical skill to operate and maintain.
- In wet weather, the nozzles may get clogged with dirt found in the wash.
- It is only economical to use on a large herds.
- High initial cost of construction.

(ii) Hand spraying

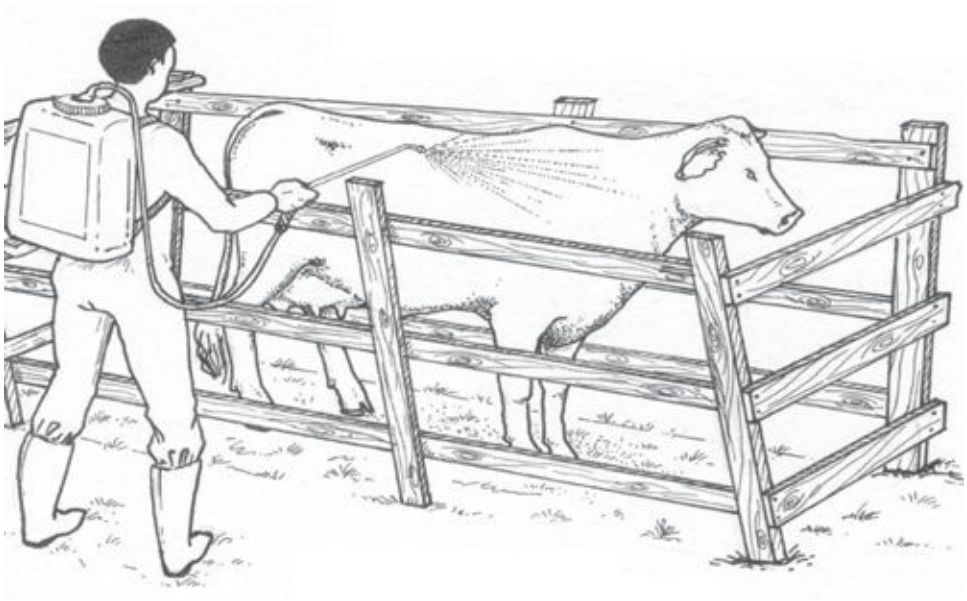


Fig. 5.17: Hand spraying of cattle

This involves the use of stirrup pump to hand spray animals. The acaricide concentration is put in a bucket then pumped out using a stirrup pump. The animals to be sprayed are confined in a crush.

The spraying procedure

(i) Spray the backline from the base of head to the tail end wetting it thoroughly.

(ii) Spray the flanks, that is, the right and left sides in order to trap the spraywash dripping down from the back to penetrate into the skin.

(iii) Spray the belly from the brisket to the udder or scrotum region.

(iv) Spray the rear and tail.

(v) Spray the front and hind legs up to the hooves.

(vi) Spray the head from the poll to the bridge of nose and sides up to the dewlap.

The whole animal's body should be thoroughly sprayed, particularly behind the ears, under the tail, tail switch, armpit and bases of horns. In order to completely wet the animal during spraying, use a high pressure spray pump. Hand-dress the animal using pygrease after spraying. This is done on common feeding sites for ticks. Preferably, clip the hair inside the ears before spraying and hand-dressing the animal.

Important: The best time for dipping or spraying is early in the

morning.

4. Breeding practices

Breeding is the selective mating of the breeding stock. The heifer and the bull should be of the right breeding age depending on the breed. Mating should be done when the female is on heat. It is advisable to synchronise heat period such that all females are mated almost at the same period. This will ensure that the calf crop is made up of calves of almost the same age. The calf crop will be marketed at the same time.

Heat synchronisation is done by introducing teaser bulls in the herd so as to stimulate ovulation in the females.

Once the females are on heat they are introduced to the bulls paddock. The females stay with the bulls for 60 days to succeed in mating. The mating ratio of bulls to cows should be 1:20.

Practical Activity 5.3

Organize a class visit to a beef production farm and observe the various management practices.

Revision Exercise 5

1 . List the breeds of beef cattle reared in Malawi.

2 . State the characteristics of a good beef animal.

3 . (a) What is vaccination?

(b) Name the various cattle diseases vaccinated against.

4 . What causes East Coast Fever in cattle?

5 . Outline the signs of trypanosomiasis in cattle.

6 . Outline the procedure of administering a liquid dewormer to a cow.

7 . State the features of a good calf pen.

Unit 6 Dairy Production

Specific objectives

By the end of this unit, you should be able to:

(a) List the breeds of cattle for dairy production.

(b) Select the breeds of cattle for dairy production.

(c) Describe management practices in dairy production.

Introduction

Most farmers in Malawi keep breeds of low production potential especially the Malawi Zebu and its crosses. They produce milk for family consumption and only sell the surplus.

Few farmers engage in commercial dairy production which leaves a wide market unexploited. Dairy farmers for example in Lilongwe are faced with many constraints like inadequate land, lack of dairy foundation stock, poor management, marketing problems among others. Milk production is a very lucrative enterprise with a steady income and has a large market both locally and internationally. The figure below shows parts of a dairy cow.

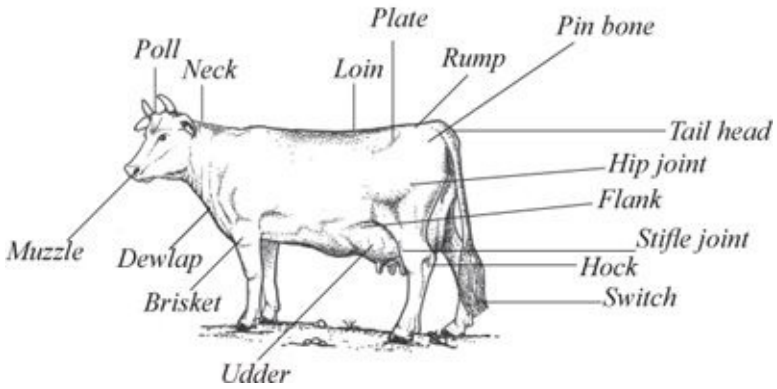


Fig. 6.1: Parts of a dairy cattle

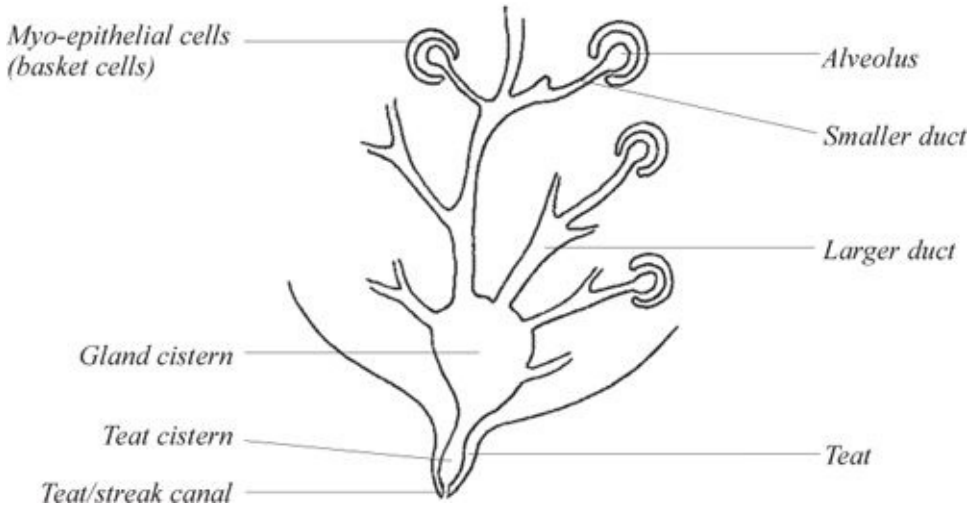


Fig. 6.2: A longitudinal secion of a mammary gland .

The mammary gland is the organ responsible for milk production in mammals. The mammary gland is composed of a balloon shaped secretory cells called alveoli (singular alveolus.)

Characteristics of dairy cattle

- Wedge or triangular-shaped when viewed from the sides.
- Long, lean and smooth neck.
- Large stomach which this enables animals to feed heavily.
- Large and well developed udder.
- Udder is firmly attached and not pendulous.
- Teats are uniform in size, well spaced and long.
- Good strong legs and well set hind quarters.
- Long, large and branching mammary veins.
- They have a straight top line.
- Bone thin with little flesh, pin bone visible.

Breeds of cattle for dairy production

There are several breeds of cattle reared for dairy production in Malawi. Among them is the Malawi zebu which is indigenous and all others are exotic.

(a) Malawi Zebu

This is an indigenous breed of Malawi. It is well adapted to the ecological

conditions of Malawi. This breed has been extensively crossed with pure dairy breeds in an effort to improve its milk production potential.

It has the following characteristics:

Size: Small bodied.

Milk yield: cows average 900 – 1000 kg per lactation.

Colour: Black, brown or white.

Other characteristics:

It has long calving intervals.

(b) Friesian (Holstein)

Origin: Holland.

Colour: Black and white body. The tail switch, legs and forehead are white.

Size: They are larger than the other breeds.

Bulls weigh 900 – 1000 kg liveweight.
Cows weigh 600 – 680 kg liveweight.
Calves weigh 35 – 40 kg at birth.

Characteristics

- Wedge shaped.
- Docile but the bulls can be vicious depending on management.
- They are poor grazers.
- Tolerant to cold but not heat.
- Under good management, they produce the largest quantity of milk, (about 9 000 kg of milk on average lactation of 305 days, that is, about 30 litres per day). Has 3.5% butterfat content in milk.
- Ideal for upgrading indigenous cattle for milk production.

Fig. 6.3: Friesian

(c) Ayrshire

Origin: Scotland.

Colour: Brown with white markings or white with brown markings.

Size: Bulls 700 kg liveweight
Cows 500 kg liveweight.
Calves weigh 30 – 35 kg at birth.

Characteristics

- Cows have straight top lines, level rumps and good udders.
- Horns are long and face upwards.
- The neck is thicker and shorter than in other breeds.
- Can withstand heat much better than Friesian because of the lighter coat colour.
- Teats are small and well spaced.
- Has 4% butterfat content in milk.
- Under good management, it produces about 6 000 kg of milk per lactation of 305 days, that is, 20 litres per day.
- Are hardy and can feed on poor pasture.

Fig. 6.4: Ayrshire with a calf

(d) Guernsey

Origin: Guernsey island, off the coast of France.

Colour: Varies from yellowish brown to almost red with white markings on the legs, face, tail, switch, and girth.

Size: Bulls weigh 700 kg liveweight.
Cows weigh 500 kg liveweight.
Calves weigh 25 – 30 kg at birth.

Characteristics

- Good for milk production.
- Fairly hardy and tolerate moderate heat and cold.
- Udders are less symmetrical than those of Jersey.
- Quiet and easy to handle.
- Under good management, milk production is about 5 000 kg per lactation of 305 days, that is, about 17 litres per day.
- Has 4.5% - 5% butterfat content.
- They are good grazers.

Fig. 6.5: Guernsey with her calf

(e) Jersey

This is the smallest of the dairy breeds.

Origin: English Channel in England.

Size: Bulls weigh 600 kg liveweight.
Cows weigh 450 kg liveweight.
Calves weigh 20 – 25 kg at birth.

Colour: This varies from light yellowish brown (fawn) to a shade of black. Tailswitch and muzzle are black. Inside the legs and underneath the stomach, the colour is lighter. The eyes are also black.

Characteristics

- Have straight top line, level rumps and dished forehead.
- Have sharp withers.
- Eyes are prominent (protrude).
- Are excellent grazers on poor pasture.
- Are nervous and sensitive.
- Are resistant to high temperatures.
- Under good management, milk yield is about 4 000 kg per lactation of 305 days, which is an average amount of 14 litres of milk per day.
- The colour of the milk is yellow.
- Has a butterfat content of 5% - 5.3%.
- Bulls are aggressive and vicious.

Fig. 6.6: Jersey bull

Practical Activity 6.1

- Visit a dairy farm, observe the dairy animals kept and list their observable characterisitcs.

Practices of dairy cattle management

1. Housing

Dairy cattle like beef cattle need proper housing to protect them against adverse environmental conditions. Housing structures like the stalls (khola) and zero grazing unit are also used in housing dairy cattle.

However, dairy cattle require an extra housing structure for milking. This structure is known as dairy shed (milking parlour).

(a) Dairy shed or parlour

A dairy shed is part of the dairy unit that is used during milking. It comprises of the following parts:

- A night shade.
- A calf pen which should be fitted with a feed and water trough.
- A feeding and watering area.
- The milking section.

• A feed and an equipment store.

There are two types of milking sheds:

(i) Permanent milking shed: This has a milking machine permanently installed at the milking section.

(ii) Movable milking shed: In this type of shed, there is a mobile dairy unit. These units are fitted with small wheels which facilitate their movement to different sites. Movable milking sheds are common in large dairy farms.

Cows are fed on concentrates while in the parlour.

Factors to consider in the construction of a dairy shed

(i) It should have a resting area where the cow can rest and chew the cud.

(ii) A dairy shed should be spacious enough to allow room for exercise enhancing proper physiological body functioning of the cow.

(iii) The dairy shed should have adequate feeding and watering space. It is important to separate these from the resting area to avoid accumulation of dung and urine around the feeding and watering points.

(iv) Separate the milking area from the feeding, watering and exercise areas.

(v) The dairy shed should have a feed and drugs store and another store for keeping milking equipment.

(vi) Calf pens must be near the dairy shed.

(vii) Provision for proper waste disposal.

(ix) The floor of the milking section, feeding, watering and exercise area need to be built of concrete to withstand the weight of the cattle and facilitate cleaning.

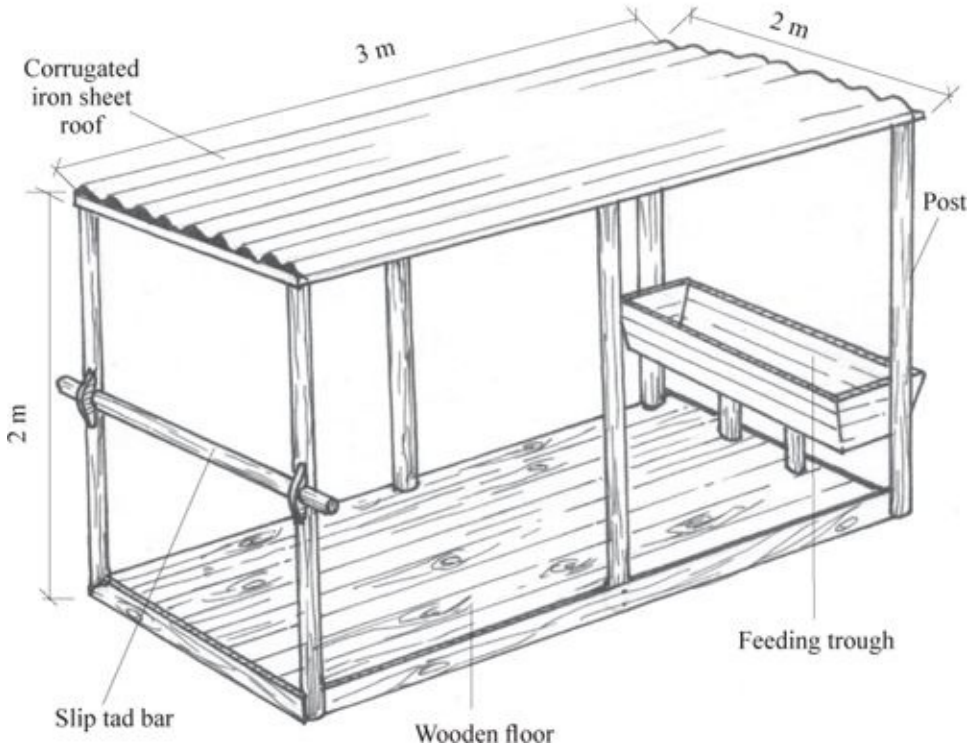


Fig 6.7: Movable dairy shed

Maintenance of a dairy shed

- Repair worn out or broken parts immediately they are noticed.
- Clean the dairy shed regularly with clean water, detergents and disinfectants.
- Ensure proper drainage in the surrounding area.
- Ensure proper ventilation.

(b) Calf pens

These are structures for housing calves. The calf pen can be either communal or individual. However, individual calf pens are most suitable since they prevent cross-suckling among calves which results in hair balls in the rumen, provide for better individual attention given to the calves and minimize spread of diseases. Calf pens should be located near or within the dairy unit.

Features of a good calf pen

- It should provide complete separation of calf from other calves thus eliminate the chances of navel suckling and spread of diseases.
- It should be easy to clean. This prevents accumulation of dirt.
- It should be spacious.

• It should allow the calf to see the mother cow and other animals.
• It should provide facilities for individual feeding and watering.
• It should allow the calf to have access to sunlight.
• It should be well ventilated to prevent infection.
• It should be durable.
• It should be economical to construct.

Types of calf pens

(a) Permanent calf pens: These are fixed on the ground and cannot be relocated to other areas. They are prominent in the zero-grazing method of livestock rearing.

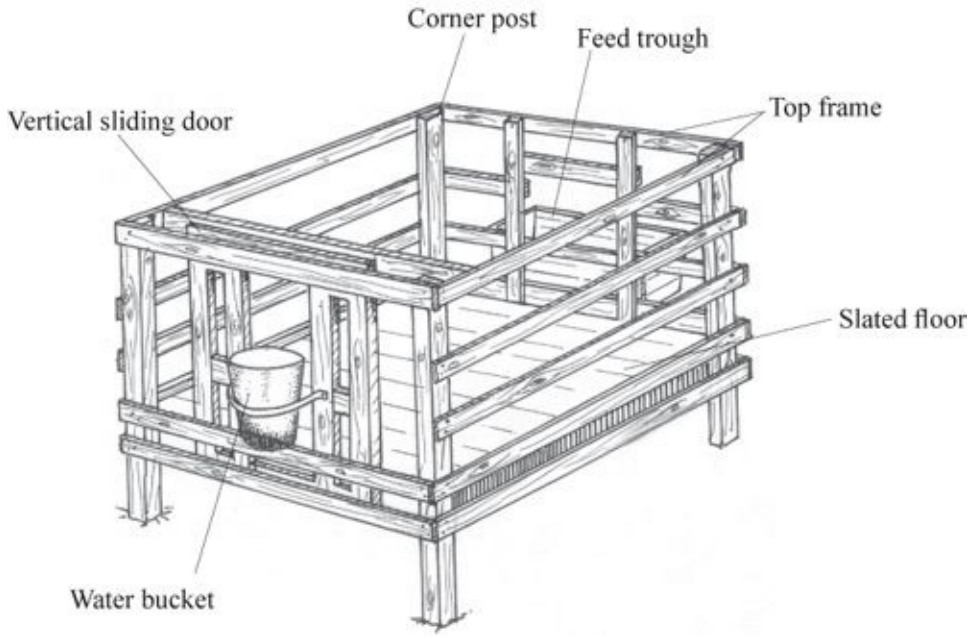


Fig. 6.8: Permanent calf pen

(b) Movable calf pens: These are mobile and can be relocated to new sites as a farmer may decide. They are most common in the paddocking method of animal grazing.

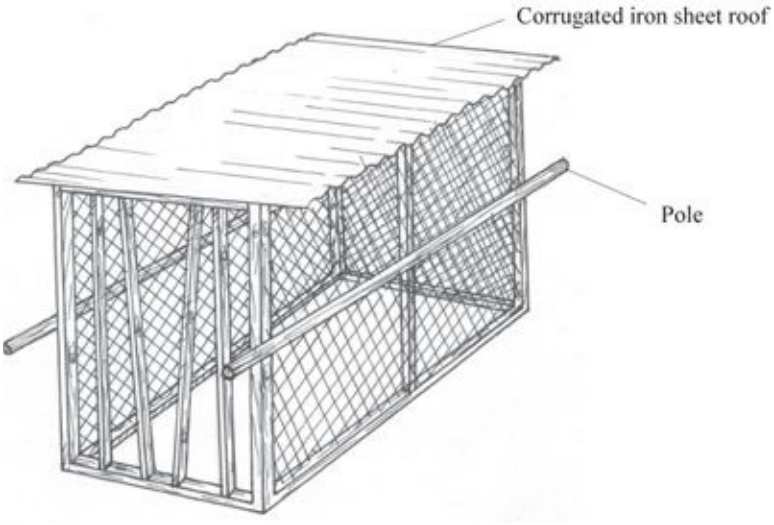


Fig. 6.9: Movable calf pen

Maintenance of a calf pen

(i) Clean the calf pen regularly.

(ii) Repair the leaking roofs to prevent wetness of the floor.

(iii) Repair any worn out parts.

(iv) Paint the walls white to keep off flies. White wash is preferred as paint.

(v) Ensure there is proper ventilation.

2. Feeding dairy cattle

Dairy cattle are also reared under extensive and intensive systems like the beef cattle.

The feeding programmes are similar, however during dry seasons, the grass is supplemented with crop residues, hay, silage, concentrates such as maize meal, cotton seed cakes, groundnut cake, Bran *(Madeya)* and mineral licks.

Dairy cows should always be provided with adequate clean water. In stall feeding, some farmers have constraints like lack of feeds and cash to buy feeds leading to diseases and nutritional disorders. There are some instances where the dairy cow requires specialised feeding such as steaming up and extra feeding during lactation. Steaming up is giving high quality feed to in-calf cow/heifer 6-8 weeks before calving down.

During lactation, the cow should be given 1 kg of concentrates for every 3 kg of milk produced above its normal yield when fed on grass alone.

For example:

If a cow produces 4 kg of milk per day when fed on grass only and 10 kg when fed on concentrates, calculate the amount of concentrate the cow requires per day.

$\frac{10 - 4}{3} = \frac{6}{3} = 2$ kg of concentrates per day.

3. Disease and parasite control in dairy cattle

The parasites and diseases discussed under beef production also attack dairy cattle and are controlled in the same way. However there are other diseases that attack dairy cattle such as mastitis, milk fever and bloat which are discussed below.

(a) Mastitis

It is an infectious disease of mammary glands which affects cattle, sheep, goats, pigs and camels.

Cause

It is caused by different species of bacteria such as *Streptococcus spp, Staphylococcus spp, Pasteurella spp* .

Pre disposing factors

(i) Injury to the udder or teats: These allow micro organisms to enter into the udder.

(ii) Poor milking hygiene.

(iii) Teat sores.

(iv) Incomplete milking: When milk is left in the teat canal, it acts as a culture media for bacterial growth.

(v) Level of milk production: High milk producers are much more prone to mastitis than low milk producers.

(vi) Age of the cow: Old cows are more prone to the disease than young ones.

(vi) Genetic factors: Some breeds are more susceptible to mastitis than others.

(vii) Pendulous udders: These are liable to mechanical injuries which facilitate mastitis infection.

Symptoms

(i) Blood clots or pus in milk.

(ii) Pain in the udder or teats during milking.

(iii) Swollen or inflammed udder.
(iv) Rise in the body temperature.
(v) Clots in milk or milk appearing as a clear liquid.
(vi) Drop in milk yield.
(vii) Blocked teat canal.
(viii) Rapid and weak pulse.

Control measures

(i) Practice farm hygiene, milk the infected cows last, use single clean towel for each cow to wipe the udder or use disposable towels.
(ii) Immediate treatment of infected cows to avoid the spread of the disease.
(iii) Test for mastitis before milking to avoid spreading it to healthy cows.
(iv) Applying milking jelly or milking salve after milking to prevent drying and cracking of teats. Use teat dip on each teat after milking.
(v) Use good milking techniques that is, squeeze method for complete milking.
(vi) Infuse long acting antibiotics into the teat canals during drying off period.
(vii) Cull those animals which do not respond to treatment.
(viii) Vaccinate the animals against mastitis once in a year.

Treatment

Administer anti-mastitis drugs or antibiotics such as Tetracycline, Streptomycin or Penicillin. If udder is inflammed give corticosteroids.

(b) Milk fever

This disease is also known as *parturient paresis* . It affects dairy cows, dairy goats, ewes and sows.

Cause

Low calcium level in the blood, a condition referred to as *hypocalcaemia* .

Susceptibility

This disease is more common in heavy milking cows. It commonly occurs in cows that are extensively fed on feeds rich in proteins but low in calcium. Hence there is no adequate calcium replacement in the body compared to its removal through milk secretion. The condition is also likely to occur between the 3^{rd} and 4^{th} lactation when milk production is at its highest either a few days to

parturition or a few days after.

It is common in animals aged 5 – 9 years. Breeds mostly affected are Jersey, Guernsey and their crosses.

Symptoms

These are observable within 12 – 72 hours before or after calving.

(i) Muscular twitching causing the animal to tremble.

(ii) Staggering as the animal moves.

(iii) Inability to stand. The animal lies down on its side most of the time.

(iv) Dull and staring eyes with dilated pupils.

(v) Extremeties feel cold to touch.

(vi) The animal lies on the sternum with its neck twisted on one side. This is called sternal recumbency.

(vii) Breathing becomes slow and weak.

(viii) The body temperature falls.

(ix) General paralysis. The animal's body functions such as urination, defaecation and milk secretion stops. This is followed by death.

Control measures

(i) Feed animals on a diet rich in calcium especially during pregnancy and early lactating periods.

(ii) Give intramuscular injection of calcium 2-3 days before calving.

(iii) Cows with past cases of milk fever should be partially milked for the first ten days that is, partial milking every two hours for the first few days. Then increase the milking level gradually until after 10 days. Thereafter carry out normal milking.

(iv) Cull susceptible animals.

Treatment

(a) Injection of calcium borogluconate solution intravenously, calfojet or calcijet intramuscularly.

(b) Pump air into the udder to limit milk synthesis.

(c) Bloat

This disease is also called **tympanites.** The disease affects cattle, sheep and goats. 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.

Cause

Bloat is caused by:

(i) Feeding animals with large amounts of legume and lush forage such as cabbage leaves and lush grass. This causes rapid fermentation producing a lot of gas in the stomach faster than the gas can escape through the oesophagus.

(ii) Abrupt change in feeds given to animals that is, from very dry feeds to very succulent feeds. Since the rumen is not used to the new feed, indigestion occurs.

(iii) Blockage of oesophagus by large food particles such as potatoes, manigolds and carrots.

(iv) Injury to the nerve supply of the rumen causing paralysis of the rumen.

Symptoms

(i) Distension of the left side of the abdomen due to gas or froth accumulation which can be felt by pressing with hand.

(ii) Difficulty in breathing.

(iii) Profuse salivation.

(iv) The animal lies down and is unable to rise up.

(v) Grunting and kicking at the belly.

(vi) Death occur within hours due to the pressure on blood vessels, heart and lungs.

Control measures

(i) Provide dry roughages just before feeding the animal on green and succulent or wet pasture.

(ii) Feed livestock on wilted grasses and pasture legumes.

Treatment

(i) Exercise the sick animal by walking it around. This will mix up the rumen contents and help in the escape of gases.

(ii) Use medicinal oils as defrothing agents such as liquid paraffin or turpentine mixed with vegetable oil.

(iii) Epsom salt can be used to empty the stomach since it acts as a laxative.

(iv) A stomach pump can be used to remove the gas. The pump is inserted into the rumen through the oesophagus.

(v) In extreme cases, trocar and canula or sharp sterilised knife is used to pierce through the skin of the rumen. After piercing, the gases escape and the animal is relieved.

(vi) Methyl silicone injected directly into the rumen to prevent frothing.

Breeding

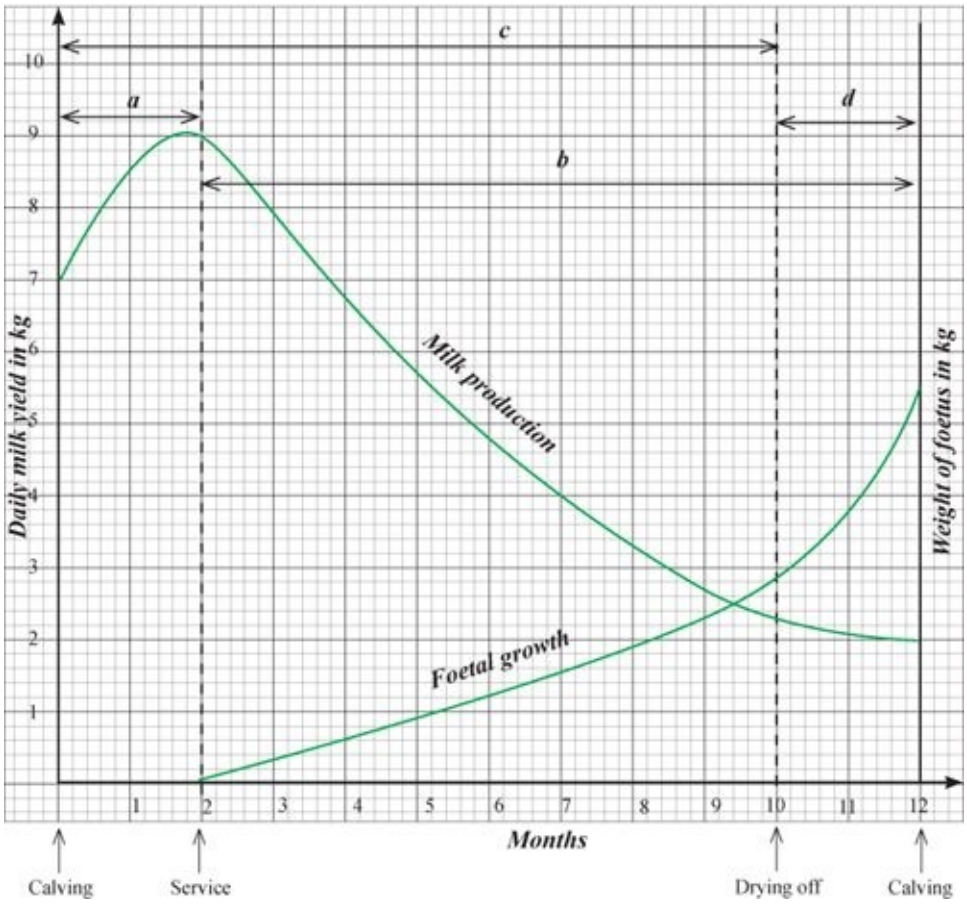
Breeding dairy cattle should be such that a calf is born by each cow per year. To achieve this, the dairy cow is given a resting period of 60 - 90 days after calving and then mated on the third month of calving.

The heifers or cows can be served either naturally or by use of artificial insemination.

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 larger ducts and is stored in the gland cistern 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



a = Resting period (2-3 months)

b = Gestation period (9 months)

c = Lactation period (10 months)

d = Dry period (2 months)

Note: • Foetal growth increases very fast upon drying off.

• As the foetus increses, the milk yield gradually declines as more nutrients are used for foetal growth.

Factors affecting milk yield

• Excitement; releases adrenaline which inhibits letdown.

• Time of milking.

• Milking methods.

• Feed given to animal during milking.

• The breed of animal.

• The condition of kraal.

• Diseases; mastitis, milk fever.
• Onset of heat.
• Stage of foetal development.

Practical Activity 6.2

Visit a dairy farm and observe the management of dairy animals.

Revision Exercise 6

1 . List the exotic breeds of dairy cattle.
2 . List four distinguishing characteristics of a jersey breed of cattle.
3 . (a) Outline the qualities of colostrum.
(b) State the advantages of bucket feeding in calf rearing.
4 . Outline the pre-disposing factors of mastitis.
5 . What measures should a farmer carry out to control mastitis in his dairy herd.

Unit 7 Anatomy and Physiology of Reproductive Systems of Cattle and Chicken

Specific objectives

By the end of this unit, you should be able to:

(a) Draw reproductive systems of cattle and chicken.

(b) Label the reproductive systems of cattle and chicken.

(c) Explain the functions of each part of the reproductive systems of cattle and chicken.

(d) State the age at puberty for cattle, sheep, goats and rabbits.

(e) Trace the oestrus cycle of a selected animal.

(f) Explain the meaning of the term 'heat' in animals.

(g) State the signs of heat.

(h) State the gestation periods of cattle, sheep, goats and rabbits.

(i) Describe the process of reproduction in cattle.

Introduction

Reproduction is the process by which new individuals are produced. The process begins when the ovum (the female gamete) unites with the sperm (the male gamete) after successful mating to form the zygote. This process of sperm uniting with ovum to form a zygote is called **fertilization.**

In all livestock, fertilisation is internal, that is it takes place inside the body of the female. Development of the zygote also takes place inside the female's body until the end of the gestation period. However, in poultry, the embryo develops within the laid egg outside the body of the female during incubation although fertilization is internal.

A reproductive system is a network of organs and accessory glands which work together to achieve reproduction.

Reproductive systems in cattle

(a) Reproductive systems in male cattle

The male reproductive system consists of the testicles (testes), sperm duct (vas deferens), seminal vesicles, the prostate, Cowper's glands and the penis.

Scrotum

This is a thin, distended skin which suspends the testicles outside the body cavity providing an ideal temperature for sperms development. It is also a protective skin for the testes.

Testicles/Testes

These are two ovoid and glandular organs enclosed in the scrotum. They produce spermatozoa (male gametes). (Singular – spermatozoon or sperm). Testicles also secrete male sex hormones. In most animals, for example cattle and sheep, testicles are suspended outside the animal's body hanging between the hind legs while in poultry they are found in abdominal cavity.

Epididymis

In connection with each testicle is the epididymis which is a large coiled tube attached on one part to each testicle and the other to the vas deferens. It acts as a temporary store for sperm cells.

Vas deferens

These are also known as **sperm ducts** and are continuous with the epididymis. They conduct sperms from the epididymis to the urethra where the reproductive system joins the urinary system.

Urethra

The urethra is a canal which runs through the penis lengthwise. It extends from the vas deferens to the end of the penis. The urethra serves as a passage for both semen and urine.

Glands

These are found at the *neck* of the urinary bladder that is, where the reproductive system meets the urinary system. They include the Cowper's glands, prostate gland, and seminal vesicles. The prostate gland produces a saline glucose rich fluid that activates the sperms. The Cowper's gland produces a mucoid fluid that

precedes the sperm and helping to neutralise the acidity of the urine in the urethra which is harmful to the sperms. The seminal vesicles are glands which produce the seminal fluid in which the sperms are carried.

> **Note:** Generally, the term semen refers to spermatozoa from the testicles mixed with the products of the glands.

Penis shaft

Penis refers to the organ that penetrates the vagina at the time of mating. It makes it possible for the introduction of sperm cells into the vagina. The penetration of the penis into the vagina is called **copulation.** The discharge of semen from the penis into the female organ is termed as **ejaculation.**

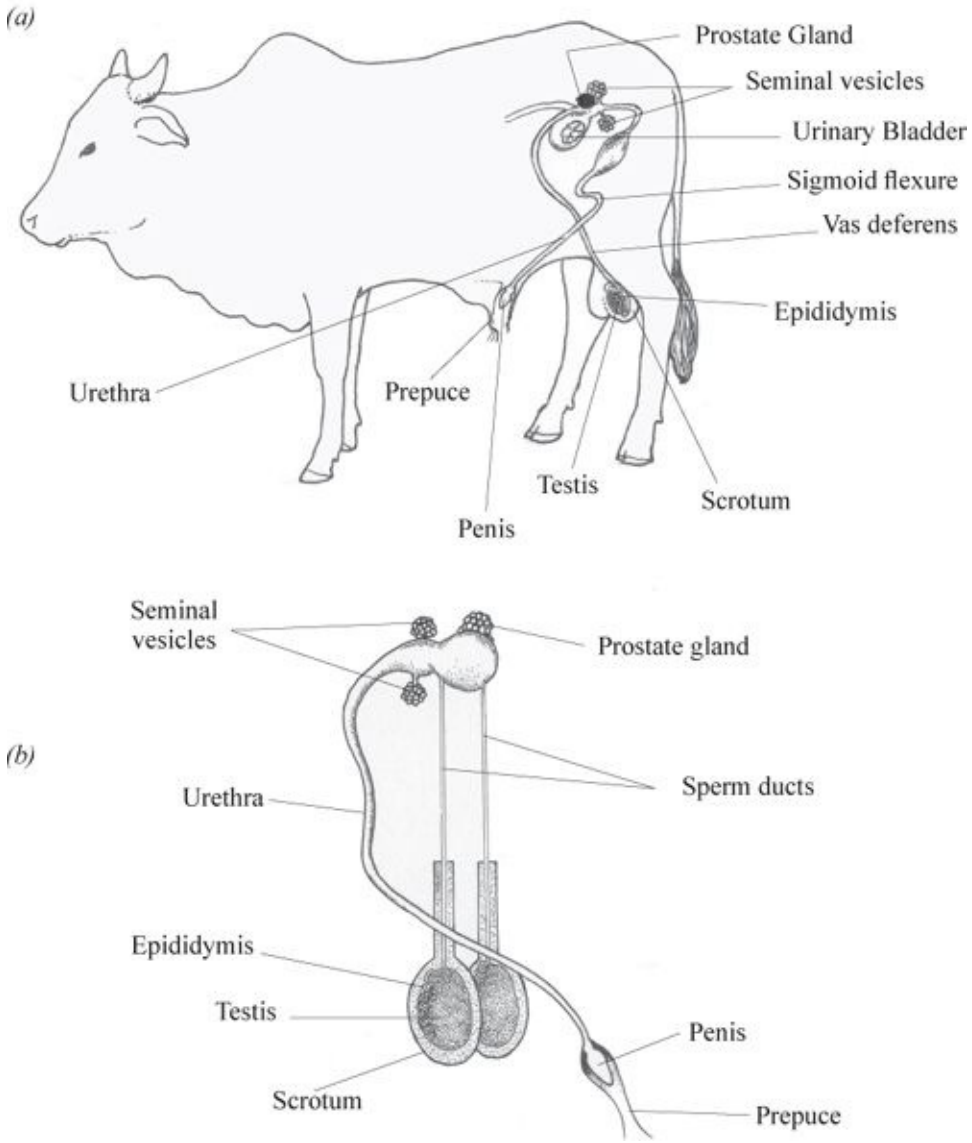


Fig. 7.1: Male reproductive organs (bull)

Sigmoid flexure

The sigmoid flexure is an S-shaped bend which enables the penis to retract after copulation.

Retractor muscle

They help in pulling the erected exposed penis back into the sheath.

Prepuce

This is also called the sheath. It has tufts of hair. It protects the glans from

external injury. The glans penis is the free end of the penis containing sensory nerves.

(b) Reproductive system in female cattle

A female reproductive system consists of two ovaries, fallopian tubes (oviducts), uterus, vagina and vulva.

Vulva

This is the external opening of the female reproductive system. The vulva conducts urine outside and receives the penis into the vagina during copulation. It also acts as a passage for the calf during parturition.

Urethra and urinary bladder

The urinary bladder stores urine while the urethra conducts urine to the floor of vagina and out through the vulva.

Vagina

The vagina is the female copulatory organ where sperms are deposited. It extends inwards from the vulva to the beginning of the uterus. It is a highly elastic passage through which a foetus is expelled from the uterus.

Cervix

This is the opening between the vagina and the uterus. It is through this opening that the spermatozoa pass. The cervix opens up and closes as necessary. During the gestation period it is usually closed, while it is wide open when an animal is on heat. During delivery the calf passes through it into the vagina.

Uterus

The uterus or womb is a two horn-shaped structure. Each of the horn-shaped structures tapers off into tubes leading to the ovaries. The zygote (fertilised ovum) settles on the upper uterine wall where it develops until birth.

The uterus has a number of membranes, that is, the foetal membrane and placenta which attach developing embryo on the uterine wall and nourish the foetus respectively.

Fallopian tubes

The fallopian tubes are also referred to as the uterine tubes or oviducts. This is where fertilisation takes place, that is, union of the spermatozoon and the ovum.

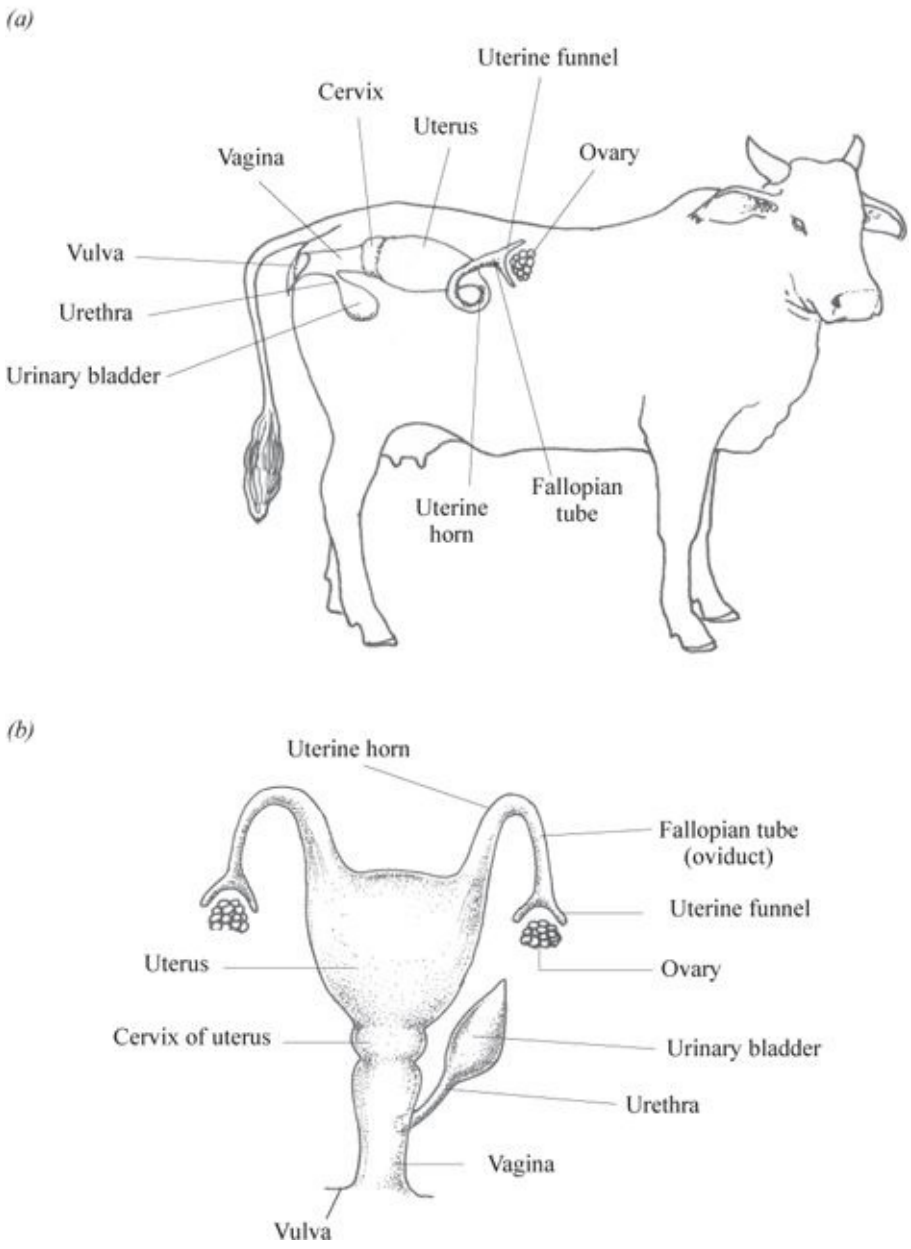


Fig. 7.2: Female reproductive system (cow) .

Fertilization may sometimes take place just as the egg emerges from the ovary or during the egg cell transit to the uterine tubes toward the uterus.

Fertilization takes place within 48 hours of service. The fertilized egg in a cow requires about 8 - 14 days to travel from the fallopian tubes into the uterus.

Funnel

The end of the fallopian tubes on the ovary form the funnels. The funnel receives the ovum during ovulation directing it into the fallopian tube.

Ovaries

These are two oval-shaped organs which produce female gametes (eggs or ova). The process of releasing eggs from the ovaries to the oviduct is called ovulation. The two ovaries alternate in ovulation during successive oestrus cycles. The ovaries also produce female sex hormones which control the sexual cycle. For example, oestrogen hormone produced by the graafian follicles in the ovary induces oestrus (heat period) in conjunction with other hormones. After fertilization, ovaries are stopped from releasing further eggs through blockage of funnel ends of the fallopian tubes by yellow mucus.

Reproductive system in chicken

(a) The reproductive system in cocks

The male reproductive system consists of testes, vas deferens, papillae and cloaca. Both testes are located at the anterior end of the kidneys in the dorsal body wall. The size of the testes varies with the reproductive cycle, that is, they are enlarged during breeding time.

Sperms from the seminiferous tubules are channeled to the epididymis. The vas deferens leads the sperms to the cloaca. The mass of convoluted ducts makes a cloacal protuberance that is conspicuous during the breeding season in males of some bird species. The straight terminal end of the vas deferens, forms a muscular ejaculatory duct that projects into the cloaca. The cloaca may under stimulation, project to the vent opening. During mating, this vent fits into the protruded cloaca of the hen and releases sperms.

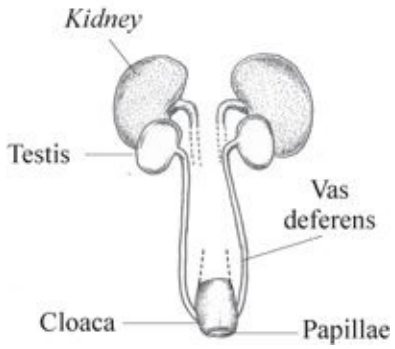


Fig. 7.3 Part of the cock's reproductive system .

(b) The reproductive system in hens

The female reproductive system of most birds has only the left ovary functional. The right side ovary is not well developed. The female reproductive system consists of one ovary and one elongated oviduct. The ovary is firmly attached to the dorsal body walls. The oviduct is, however, suspended by muscular bundles and connective tissue.

Ovary

This is a large mass of tissue located at the anterior ends of the kidneys. Within it are many ova (yolks) at different stages of development.

In an ovary, there are about 3000-4000 yolks but only a few reach maturity and get ovulated. Each mature yolk hangs from the ovary wall suspended by a slender stalk.

Fig. 7.4 The oviduct of a hen .

The Oviduct

During egg formation, the oviduct receives the yolks released by the ovary. Wave like contractions move the yolk along the oviduct.

Fertilization and addition of albumen, water, shell membrane and egg shell takes place in the different parts of the oviduct. The oviduct is divided into five parts:

(i) The funnel (infundibulum).

(ii) Magnum.

(iii) Isthmus.

(iv) Uterus (shell gland) and

(v) Vagina and cloaca.

Each part has a particular function. On average, the oviduct is about 65 cm long.

(i) Infundibulum

This is also called the funnel. It engulfs the ovulated yolk. The infundibulum is thin-walled and ciliated. It has sperm nests which store sperms. The yolk is fertilized here. The infundibulum also forms the chalaza, which is a membrane of twisted strings that suspends the yolk in position. The infundibulum is about 10 cm long and the egg takes about 15 mins here before passing down to the magnum.

(ii) Magnum

The magnum is highly glandular and has an outer longitudinal layer which is spirally arranged. It causes rotation of the yolk as albumen is added on it. It is about 37 cm long. The egg takes about 3 hours to pass through it to the isthmus.

(iii) Isthmus

Here, thin outer albumen is added to the egg. Water, vitamins and mineral salts are also added. Thereafter, the two shell membranes are added to enclose the egg contents, thus determining the shape of the egg. Isthmus is about 12 cm long and an egg takes about 1¼ hours in it before moving into the uterus.

(iv) Uterus

It is also called the shell gland. It is thick-walled and adds water and mineral salts by the process of osmosis to the dense albumen hence increasing its volume. Shell is put on the egg here through deposition of a lot of calcium deposits, followed by addition of shell pigments. The shell protects the egg contents, gives its ultimate shape and allows gaseous exchange. The uterus is about 8 cm long and an egg takes about 18 - 21 hours in the shell gland from where it is ready for laying.

(v) Vagina and cloaca

The fully formed egg passes quickly through this part of the oviduct with the large end of the egg leading. The vagina is about 7 cm long.

At the laying of an egg, the uterus usually protrudes beyond the cloaca to the outside and gently deposits the egg and then retracts. This prevents contamination of the egg by the faecal material in the cloaca. The process of laying is called *oviposition* . After laying, another ovulation takes place after about 30 minutes.

The cloaca serves as a copulatory organ where the vent of the hen opens to the cloaca of a cock and sperms are deposited into it. They then flow through the

oviduct up to the sperm nests.

> **Note:** The process of egg formation in a hen takes about 24 - 36 hours before the egg is laid. Thus, a hen is able to lay only one egg a day.

Puberty

This is a stage of sexual maturity or reproductive competence in animals.
It is a stage when an animal has the ability to release gametes and manifest a complete sexual behaviour sequence. It is controlled by hormones. In males, the hormone testosterone controls the maturation of reproductive system as well as the sperms and the desire to mate. In females, the hormone estrogen, controls the maturation of the reproductive system, egg development and ovulation.

The following table shows the age at puberty for some animals.

Species	Male	Female
Cattle	11 months	11 months
Sheep	7 months	7months
Goats	7 months	7 moths
rabbits	3 – 4 months	3 – 4 months

Table 7.1: Age at puberty for some animals

Factors affecting the onset of puberty

- Genetics: Different breeds reach puberty at different ages for example Jersey reaches puberty earlier than Friesian, Aberdeen Angus reaches puberty earlier than Charolais.
- Animal type: Dairy cattle reach puberty earlier than beef cattle (*Bos tausus* reaches puberty earlier than *Bos inducus*).
- Cross breeds reach puberty earlier than pure breeds due to heterosis.
- Body weight is a more important factor influencing puberty than age of the animal for example, dairy cattle will reach puberty when they have attained 30 – 40% of the adult weight, beef cattle at 45 – 55% of the adult weight and sheep at 40 – 50% of adult weight.
- Nutrition: Poorly fed animals will delay puberty while flush feeding may stimulate puberty (giving feeds high in energy in large quantities)

- Warmer temperatures lead to puberty earlier while extremes of temperature extend the onset.
- Exposure to opposite sex: Animals exposed to opposite sex reach puberty earlier than those raised in same sex groupings. This is due to pheromone effect.
- Exotic breeds reach puberty earlier than indigenous breeds.

Oestrus cycle

This is the period between two successive heat periods in animals. Heat periods occur in animals during the time of ovulation when the female is ready to mate. Ovulation is the discharge of the ovum from the graafian follicle of the ovary. In most farm animals, it occurs near the end of the oestrus and in others like pigs and rabbits it occurs spontaneously.

Livestock species	Length of oestrus cycle (14 days)	Duration of oestrus in hours	Ovulation period in houses
Cattel (cow)	19 – 23	10 – 26	4 – 16 hrs after onset of oestrus
Sheep (ewe)	15 – 17	24 – 26	36 – 40 hrs after onset of oustrus
Goat (nanny)	15 – 18	24 – 96	12 – 36 hrs after onset of oestrus
Pig (sow)	19 – 21	60 hours	36 hrs after onset
Horse (mare)	19 – 21	72	24 hours after onset
Camel (cow)	15 - 35	36	36 hours after copulation.

Table 7.2: Oestrus cyle and ovulation periods

Oestrus cycle in cows

The knowledge of oestrus cycle in cows is necessary if a farmer is to carry out successful breeding programme. This is because it enables the farmer to ensure mating of animals is done at the right time.

The oestrus cycle in cows occurs in four phases:

- Proestrus.
- Oestrus.
- Metoestrus.
- Dioestrus.

Proestrus (Day 17 – 20)

There is regression of the corpus luteum of the previous cycle hence a drop in the progesterone concentration in circulation. The dominant follicle outgrows the others producing increasing amounts of oestradiol. In late proestrus, the influence of oestrogen on the reproductive tract and behaviour of cows can be observed.

Oestrus (Day one of new cycle)

The dominant follicle reaches its maximum growth, matures and ruptures releasing the ovum. Ovulation takes place approximately 30 hours after the onset of oestrus and after the behavioural signs of oestrus have ceased. Ovulation is induced by high concentration of luteinising hormone.

Behavioural signs of oestrus are due to the influence of oestrogen and include:

- Restlessness.
- Drop in milk production.
- Standing to be mounted.
- Presence of clear mucus discharge from the vulva.
- Reddening of the vulva.

Metoestrus (Day 2 – 4)

In this period, the oestrus ends and corpus luteum is formed. Progesterone levels in circulation begin to rise. During this time, a phenomenon known as 'Metoestrus bleeding' occurs in approximately 90% of heifers and not more than 45% of cows. Patches and streaks of blood are seen in the vaginal mucus staining the tail and perineum.

> **Note:** The presence of blood in the mucus is not an indicator of conception or a failure to conceive.

Dioestrus (Day 5 – 17)

This is a period of maximum corpus luteum size and function. There are high levels of progesterone in circulation. At the end of dioestrus luteolysis of the corpus luteum begins.

The meaning of the term 'heat'

Heat is a period during the reproductive cycle when the female animals become sexually receptive, signaling they are ready for mating.

The female animals show certain behavioural and physiological indicators of this

period. The best times to observe for these signs are during cool times of the day for example, early morning, before feeding and milking, early afternoon and late evening.

Signs of heat in cows

A cow or heifer ready for service will show the following signs:

(i) It becomes restless or moves about searching for a male.

(ii) The vulva swells or becomes enlarged, flabby, red and wet.

(iii) There is clear mucus discharge from the vulva.

(iv) There is reduced appetite.

(v) The animal attempts to ride or mount on other cows in the herd or stands still when mounted or ridden by other cows.

(vi) The cow bellows or moos unnecessarily.

(vii) The milk yield in lactating cows drops suddenly.

(viii) Frequent urination.

(ix) There is a slight rise in body temperature.

(x) The cow sniffs other animals on the vulva and allows others to sniff it.

For successful mating, the male and female should mate during the ovulation period. The best time for serving a cow on heat is 12 hours after the onset of heat (morning – evening rule) that is if the signs of heat were observed in the morning, serve the cow in the evening and if it was observed in the afternoon serve it in the morning.

Signs of heat in ewes

An ewe on heat will show the following signs:

(i) Seeks out for rams.

(ii) Stands to be mounted.

(iii) Rapid tail movement or raised tail in the presence of a ram.

(iv) Nervousness.

(v) Increased vocalizations.

(vi) Decrease in appetite.

(vii) Reddened and swollen vulva.

Signs of heat in goats (nanny)

A nanny on heat will show the following signs:

(i) Restlessness
(ii) Mounting others and stand still to be mounted
(iii) It seeks out for males
(iv) Constant vocalizations.
(v) Loss of appetite
(vi) Rubbing up against herd-mates
(vii) Redness and swelling around the vulva
(viii) Thin clear mucus discharges from the vulva.

Signs of heat in rabbits (doe)

A rabbit doe on heat will show the following signs:
(i) It becomes restless and tries to contact other rabbits in adjacent hutch.
(ii) The external genitalia becomes red and swollen.
(iii) It rubs against the walls and food containers.
(iv) It throws itself on its sides.
(v) When mounted it bends its tail up over the back.
(vi) Frequent urination.

Practical Activity 7.1

• Visit a livestock farm and observe signs of heat in cattle.

Gestation period

This is a period from conception to the birth of a young animal. It varies from one animal species to another.
The table below shows gestation periods of various farm animals.

Animal species	Length of gestation (days)
Cow	275 – 285
Sheep (ewe)	150
Goat (nanny)	143 – 153
Rabbits (doe)	28 – 32

Table 7.3: Gestation period of farm animals

Practical Activity 7.2

• Visit a nearby farm and research on the gestation period of the farm animals.

Processes of reproduction in cattle

Reproduction in cattle involves the following processes:

1. Mating

This can be natural or artificial insemination (A.I). In natural mating, a bull directly mounts a female on heat and introduces semen into the reproductive tract of the cow.

In artificial insemination (A.I), semen collected from a superior male is introduced into the female reproductive tract by use of a pistolette, syringe or other means.

2. Fertilisation

This is a process through which the nucleus of a male gamete fuses with the nucleus of a female gamete to form a zygote. This occurs in the upper part of the oviduct after copulation or introduction of sperms. The zygote moves down the oviduct to the uterus and as it moves, it undergoes several cell division to form a hollow mass of cells. It develops finger-like projections called villi with which it attaches itself on the wall of the uterus in a process called **implantation.**

The villi together with the walls of uterus develop into a special organ called the **placenta.** Upon implantation, it becomes an embryo.

3. Embryo development

During the early stages of embryo development, the villi forms the sites of material exchange between the embryo and maternal blood vessels in the uterine wall. Amnion (a membrane) surrounds the embryo forming an amniotic cavity within which the embryo lies. The amniotic cavity is filled with a fluid secreted by the amnion called **amniotic fluid.** This fluid suspends the foetus, providing it with support and also acts as shock absorber to protect the foetus against mechanical injury. The embryo is attached to the placenta by a tube called the **umbilical cord.** The tube increases in length as the embryo develops. The embryo becomes a foetus at about 3 months of pregnancy.

Foetus development

The foetus has fully differentiated organs and tissues and it gets nourishment through the placenta. The placenta provides a close association between the maternal and foetal blood circulations. By the end of the gestation period, all the organ systems are fully developed.

Feeding of foetus

The foetus gets the following food nutrients from the maternal circulation across the placenta:

- Digested food substances such as glucose, amino acids, fatty acids and glycerol.
- Vitamins.
- Mineral salts.
- Water.

These food nutrients are used in the development of the foetus.

Respiration of foetus

Oxygen diffuses into the foetal blood circulation system across the placenta from maternal blood circulation. The oxygen is used in the oxidation processes of glucose within the cells releasing water, energy and other metabolic wastes.

Excretion

The foetal waste products which include nitrogenous wastes and carbon dioxide diffuses out of foetal blood circulation into the maternal blood system.

Parturition

This is the process of giving birth.

Signs of parturition in cows

A cow which is about to parturate shows the following signs:

(i) Restlessness.

(ii) Loss of appetite.

(iii) Enlargement of udder that is, the udder is fully filled with colostrum.

(iv) Colostrum may drip out of the teats in high lactating cows.

(v) The vulva swells and becomes red, much larger and flabby.

(vi) Slimy mucous discharge from the vulva.

(vii) The cow isolates itself from rest of the herd.

(viii) There is relaxation of ligaments on either side of the pelvic bones. This causes the pin-bones to widen.

Management of cows during parturition

Parturition in cattle is referred to as **calving.** Keep a record of when the cow is to calve. Gestation period normally lasts 275 - 285 days. Put the in-calf cow in the nurse paddock a week to parturition. The nurse paddock is very important as it is where:

(i) The animal can be fed on high quality pasture that provides nutrients for the body to build enough energy reserve for ease of calving down.

(ii) The farmer can carry out close supervision of the animal towards labour time.

The day of calving

Look out for the signs of parturition and keep a close watch on the cow and provide assistance when it is needed. Do not disturb the cow when calving, but stand nearby.

The cow usually takes about 5 hours to calve after the onset of labour. When the calf is coming out, front legs appear first followed by the head resting on them that is, normal presentation. This is usually after the water bag bursts. In case the cow fails to deliver by itself, provide the following assistance:

(i) Hold the fetlock and pull the calf down as the animal strains to push.

(ii) Pull the calf out down towards the udder and not horizontally or sideways.

Signs of complications during the process of parturition

(i) A long delay in the appearance of the calf once the water bag breaks.

(ii) If calving is taking more than 3 hours after some parts of the calf appear.

(iii) If the calf is coming out abnormally that is, rear parts trying to come out first. This is called **breech presentation.**

(iv) If the cow is in distress such that there is no sign of water bag after many hours of straining.

(v) Only one limb appearing after the waterbag has burst.

(vi) Discharge of smelly fluid indicating death of the calf.

Precaution

(i) When the attendant deems it necessary to assist the cow, the hands must be properly cleaned and disinfected.

(ii) Use clean and disinfected hand-gears such as polythene gloves.

(iii) Restrain the cow and determine the positioning of the calf.

(iv) Check on the proper presentation of the calf, that is, the fetlock of forelegs leading and their dew-claws pointing downwards and the calf's head resting on the forelegs.

(v) If the cow still cannot deliver by itself, then the attendant can assist by tying the fetlock above the dew claws and pulling according to the cow's straining rhythm.

(vi) Once the shoulders are brought out, it is then easy to pull out the calf.

Types of calving complications

1. When one or both fore legs are bent backwards as the head protrudes. Assist by pushing the head back inside so as to allow the legs to be drawn out. Carefully lift the legs within the womb, ensuring that the hooves do not scrape the uterine wall. Position them in front with the head resting on them so that calving can proceed normally.
2. If the head is twisted backwards to either side, correct the situation by pulling the head around and position it on top of the legs so that normal presentation is achieved.
3. Breech presentation of the calf: This is the situation where the rear of the calf comes out first instead of the fore legs. If this occurs, it is necessary to re-position the calf by turning it around completely within the womb to the correct position.
4. When the whole reproductive tract is twisted: This is a very rare occurrence. It can be established by inserting the hand through the vulva. If the hand cannot go beyond the vagina and there is no sign of water bag or calf coming out, then it is the most probable condition. It is a very complicated condition and an expert must be sought to provide assistance.

Note: As a general rule, it is necessary that in any abnormal

presentation, the calf should be re-positioned to the normal presentation. If the attendant is not able to correct any of the complications, then a veterinary surgeon must be contacted for help.

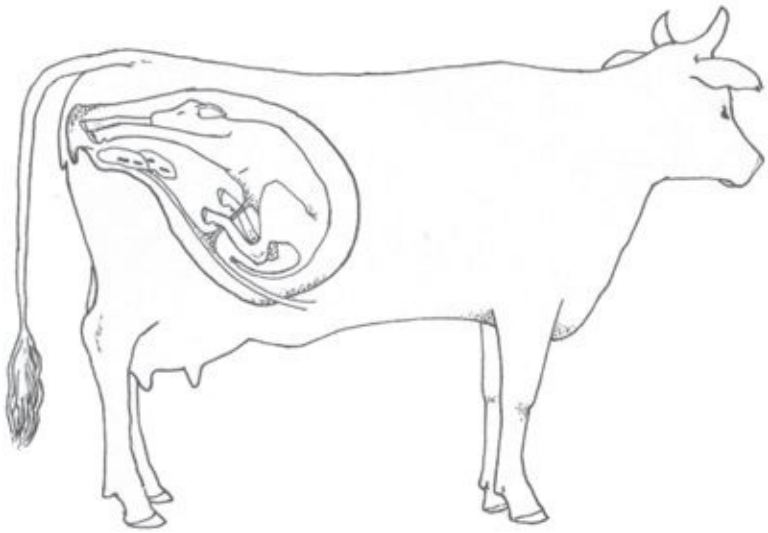
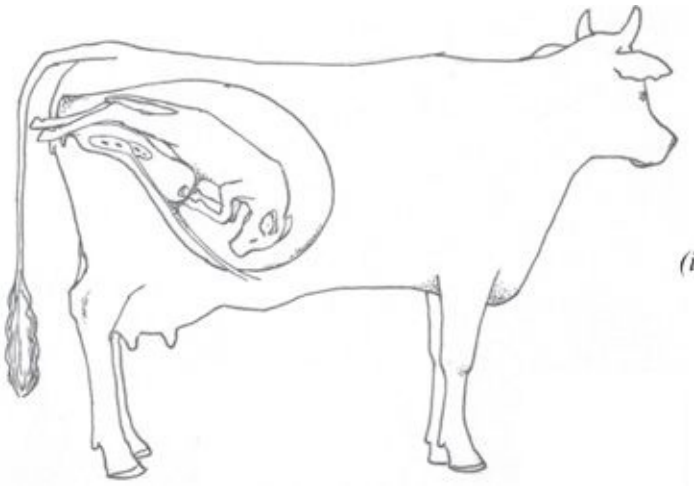


Fig. 7.5 (i): Normal calf presentation



(ii) Breech presentation.

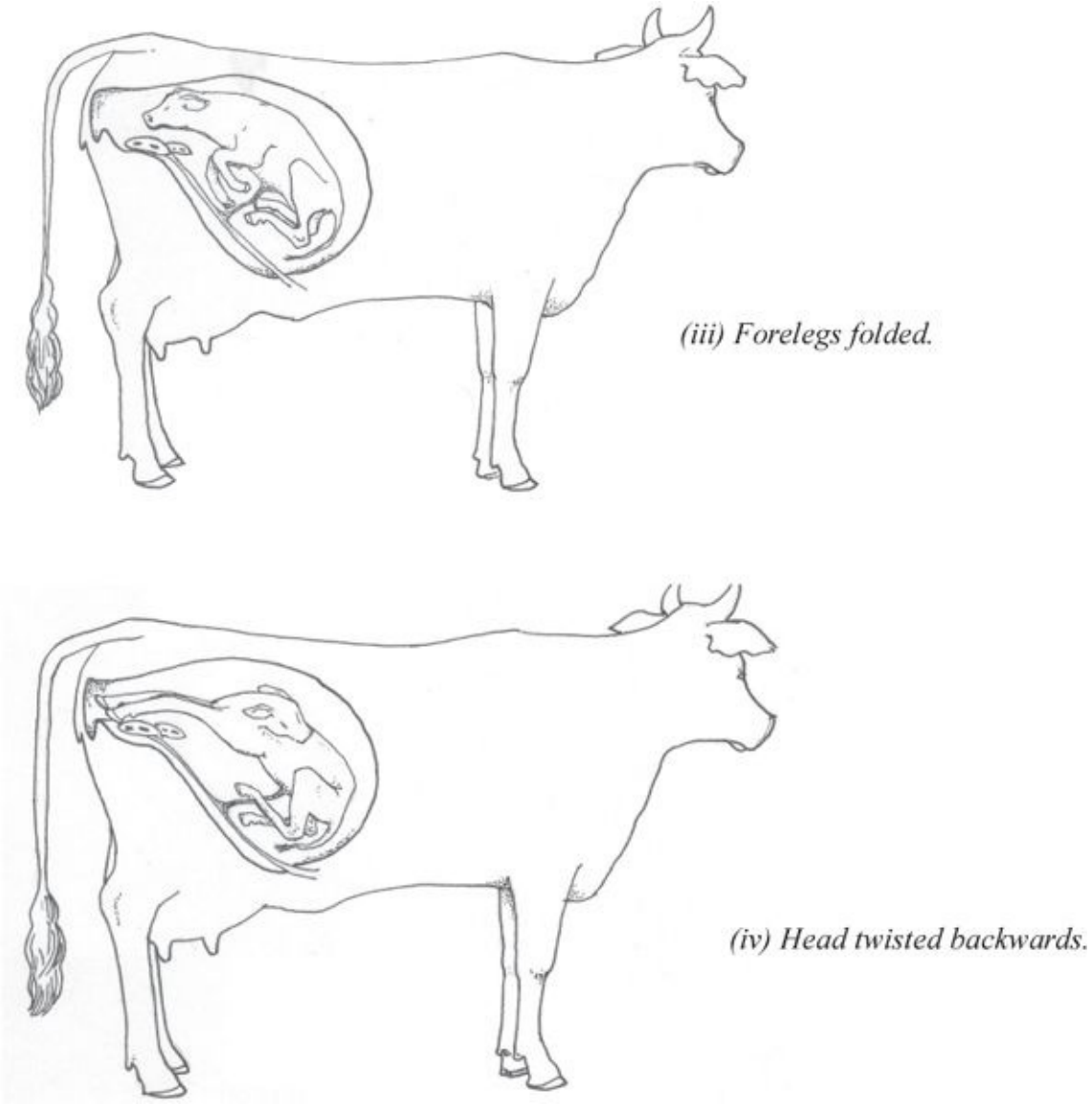


Fig. 7.5 (ii), (iii) and (iv): Abnormal calf presentations

Whenever providing help to a cow during parturition, remember to do the following:

(i) Wash your hands and arms with warm soapy water mixed with antiseptic. Also clean and disinfect materials for use or use sterilised equipment. If the cow's vulva has dried out, lubricate it with clean, warm soapy water.

(ii) Restrain the cow and check if the calf is oriented in its normal position. Do not use excess force while pulling the calf.

(iii) When the cow needs help, provide it immediately. Get the calf out as soon as possible and make sure the cow rises up after giving birth to avoid incidences of calving paralysis.

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

Care after calving

Immediately after calving, the following should be done by the attendant:

(a) Let the cow lick the calf dry. Ensure the nostrils, mouth and body are cleared of mucous (use clean rag to wipe if the cow does not lick). The rough licking action of the cow's tongue stimulates blood circulation in the calf.

(b) Tie, cut and disinfect the umblical cord. Use a sterilised scalpel and apply tincture of iodine or dettol on the cut surface to prevent later bacterial infection.

(c) Assist the calves if they cannot breathe. Get a clean straw and tickle the nostrils or try lifting it up and lowering it several times. Alternatively, splash cold water over the face of the calf. If these cannot work then carry out mouth-to-nose resuscitation (kiss of life).

(d) Weigh and record the birth weight.

(e) Ensure the calf suckles colostrum. Assist weak calves to locate the teats.

(f) After suckling colostrum, move the calf to a warm pen during chilly weather conditions.

(g) The afterbirth (placenta) is normally expelled soon after calving (usually within one hour though it can stay for 2-3 hrs after the parturition). If it is retained for a longer period or hangs partially outside, it is necessary to seek help from a veterinary officer to remove it.

(h) Provide the cow with a lot of clean drinking water.

(i) Give the cow high quality feeds.

Practical Activity 7.3

- Visit a nearby farm and observe parturition in cattle.

Revision Exercise 7

1 . What is the function of the following parts in cattle reproduction?

(a) Scrotum

(b) Prostate gland

2 . (a) What does the term oestrus cycle mean?

(b) If a dairy cow is noticed to be showing signs of heat at 6 a.m, what time should it be inseminated?

3 . Outline the phases of oestrus cycle in cattle.

4 . Give the signs of heat in goats.

5 . Explain the feeding of a foetus.

6 . State the common calving complications.

Unit 8 Livestock Improvement

Specific objectives

By the end of this unit, you should be able to:

(a) Explain the meaning of the term ‘livestock improvement’.

(b) State the aims of livestock improvement.

(c) Describe the methods of livestock improvement.

(d) Identify characteristics of livestock to be selected for breeding.

(e) Describe livestock breeding systems.

Introduction

Over the last few years, Malawi has been experiencing shortage of livestock products such as milk, meat and eggs.

This has been solved by importing these products from other countries. However, livestock improvement which deals with providing the right genetic constitution will play a major role in increasing livestock output.

Farmers should keep animals with certain desirable characteristics such as tolerance to harsh environmental conditions, high resistance to parasite and disease attack and high production potential.

Livestock constitutes a relatively small sub-sector within Malawi’s agriculture. However, this can be reversed through proper animal breeding systems.

Meaning of livestock improvement

Livestock improvement refers to the science of changing the genetic constitution of animals in order to have desired characteristics.

The improvement of farm animals, by simply selecting those with desirable characteristics to breed, is a highly effective and sustainable means of improving livestock.

Aims of livestock improvement

Major aims of breeding livestock are:

(a) To obtain high quality of animal products such as milk, meat and wool.

(b) To increase production capacity of the animal, that is, its production potential.

(c) To increase the disease resistance of the animal.

(d) To increase the animals' tolerance to high ambient temperatures and to other adverse environmental conditions.

Methods of livestock improvement

There are three main methods of livestock improvement. These are:

- Selection.
- Breeding.
- Introduction.

Selection

This is the practice of making deliberate decision to allow some animals to be the parents of the next generation.

Animals are selected on the basis of characteristics which are easily assessed, for example productivity and adaptability to the environment. The selected animals form the breeding stock.

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

This involves the selection of individuals based on their performance. The outward appearance of the animals; phenotypic characteristics, are used to choose the best animal. Such characteristics are observable or measurable.

Observable characteristics include coat colour, size of the body and shape of the head. Measurable characteristics include body weight and milk yield. Animals with the best characteristics are chosen.

Under this method of selection, the animals chosen to be the parents are those whose performance are closest to the breeding objective. For example, in dairy cattle, the herd chosen should be that producing high milk yields. This method is used for characteristics that have high chances of being inherited by the offsprings.

(b) Selection by contemporary comparison

This is the 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. During its lifetime, a male produces many more offsprings than a female. Therefore, progeny testing is applied much more widely to males than to females. Progeny testing is of importance when considering production of eggs or milk which the male does not produce itself but only transmits the production potential to its female offsprings.

(d) Sib-selection

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

In order to get the best results from progeny testing, the following points are important:

- 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, for instance, 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.

> **Note:** Progeny testing takes time and the keeping of progeny groups (offsprings) for a long time can be an expensive operation.

There is also the added cost of keeping bulls while awaiting the results of their progeny testing.

Review Exercise

In groups of three or five discuss the advantages and disadvantages of the three methods of selection. Which is the most suitable for farmers within your school/home environment?

Breeding

This is the process of mating selected animals for the purpose of producing animals with desired traits.

The quality of an animal depends on the genetic characteristics inherited from the parent stock and the prevailing conditions under which the animal is raised. The farmer must therefore be concerned with the parent stock from which he/she expects to produce progeny (or the young) and must carry out good routine management practices on the animals. However, what an animal may become largely depends upon what is in the egg cell from the female parent and the sperm cell from the male parent. This is the essence of breeding.

Terms used in breeding

An animal's body consists of cells. Each cell has a nucleus. Within the nuclei of cells are structures called **chromosomes** which carry the units of inheritance called **genes.** Different animal species have different number of chromosomes contained in their cells. For example cattle have sixty and pigs have thirty-eight. The genes determine the characteristics of an individual.

Genes are arranged along chromosomes in a very definite manner, which has enabled the scientists to determine the position loci of genes. A gene found on one chromosome is matched by another gene at the same position on the other chromosome forming a pair (homologous chromosomes). A pair of alternative forms of a gene which define a characteristic is called an **allele.**

Variation in animal characteristics is caused by dominance or epistatic deviation of the alleles.

Dominant and recessive genes

Many inherited traits are determined by a pair of genes. Some traits are produced by the combined effect of two or more pairs of genes. An allele may express

itself more than the other, thus it is said to be dominant. For example, when a pure bred polled bull is mated with a pure bred horned cow and the offspring produced is polled (the offspring has no horns), then polledness is **dominant** whereas the other characteristic of possessing horns is said to be **recessive.**

Dominance refers to the breeding character that suppresses the other. **Recessive** means the character has been suppressed or dominated (masked) by another character. A dominant trait always appears if the dominant gene is present. An allele is said to be dominant if it is always expressed in the physical appearance of an animal. The recessive trait recedes from expression if a dominant gene is present. It will only express itself when the dominant gene is absent (homozygous recessive form/trait.

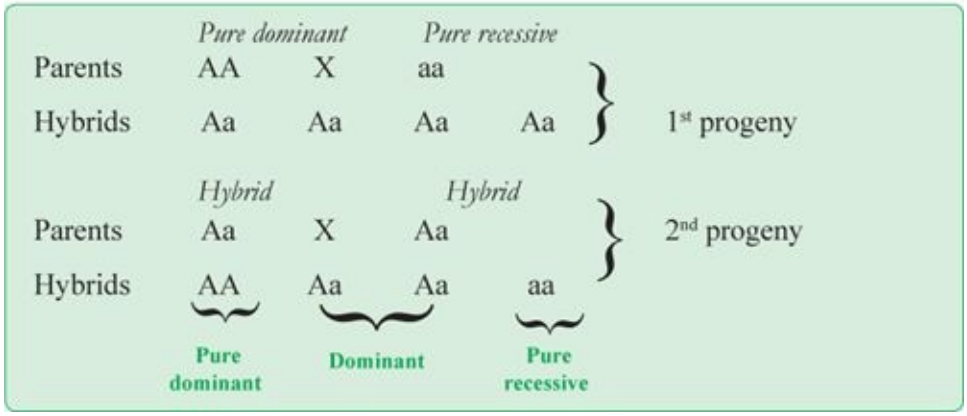
What is the difference between a recessive and dominant gene?

When dominant and recessive characters are brought together, the progeny will possess dominant characteristics. In the next generation, this offspring will produce some animals that show dominant characteristics and others which express the recessive characteristics. For example, in cattle, black colour is dominant. It explains why an offspring from Aberdeen Angus bull and a Friesian cow is usually black. When a Friesian bull is mated to a Guernsey cow, the calf has black and white colours like that of Friesian. As a general rule, darker colours are dominant over lighter colours.

Hybrid vigour (*Heterosis*)

An animal is considered a hybrid if any of its characteristics is determined by a combination of one dominant and one recessive gene. When a hybrid is crossed with another hybrid, 75 percent of the progeny will show the characteristics of the dominant gene out of which only about one-third are purely dominant. The other two-thirds have the appearance of the dominant but are hybrid. Those that show recessive characteristics are pure recessives.

Note: Recessive traits are expressed only in pure recessive while dominant traits are expressed in either pure dominants or a combined pair of dominant gene and recessive gene.



Heterosis (hybrid vigour), is a term applied to the increase in performance of offsprings much above their parents as a result of crossing two unrelated animals. They must be two pure breeds. Genes which produce vigour are dominant to those genes lacking in vigour. The hybrids exploit the good traits from either of the two parents. This is because from the crossing of the two breeds, a larger number of dominant genes are brought together in the progeny than are found in parental animals of the same breed. However, it is difficult to determine in crossing which animal produces the most hybrid vigour.

Hybrid vigour is mostly evident when the animals crossed are completely unrelated. For example, in cattle, the cross-breeding of a *Bos taurus* and a *Bos indicus* animal results in progeny that have average performance between the parents. Hybrid vigour is always shown in the first crossing.

The crossing of two superior animals of different breeds usually results in;

(a) an increase in growth rate.

(b) an increase in fertility.

(c) improvement in body conformation.

(d) an increase in production.

Epistasis

This is a situation in which one of allelic genes prevents the expression of all other allelic alternatives. The presence of one gene suppresses the action of another. The allele which masks the other is called an **epistatic gene** and that which is masked is called a **hypostatic gene.** The situation occurs where there is interaction of genes at two or more loci. Epistatic and hypostatic genes occur at different loci on the same chromosome so that the phenotype (a particular trait) is determined on the locus.

An example of epistasis is the genetic control of comb types in poultry. The

common forms of comb found in chicken are ***rose, pea, walnut*** and ***single combs*** **.** When two combs; pea and rose with epistatic expression are crossed with each other, an entirely new kind of comb results. This is the walnut comb. Each of these epistatic genes supplements the other in the production of a kind of comb which is different from either of the two. Hence, the resulting character is merely the phenotypic expression of the combination of epistatic genes. In poultry, when there is no epistatic gene present, the result will be a single comb.

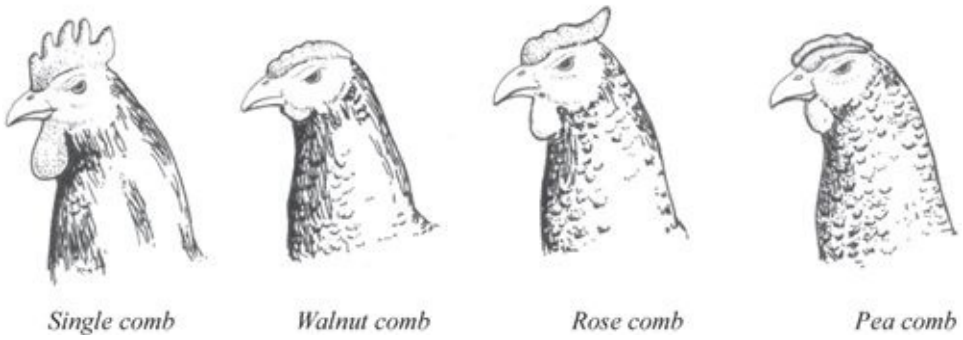


Fig.8.1: Different types of combs in poultry .

Introduction

This is the process of importing exotic, pure bred animals with superior qualities from another country. All exotic animals like dairy breeds such as, Friesians and Jerseys were introduced into Malawi from other countries.

It can be done by importing superior males, importing bulls and importing embryos.

The males imported or semen harvested from them can be used to mate the local female animals. The semen harvested and the one imported can be introduced into the reproductive system of the local female animals. This is called **artificial insemination** (AI). Imported superior embryo are implanted in the uterus of local female animals. This is known as **embryo transfer.**

Methods of service in livestock

There are three methods of service used in livestock:

1. Natural mating.
2. Artificial insemination.
3. Embryo transplant/transfer.

1. Natural mating

This is where a male animal is directly used to serve a female animal. This service occurs independent of man. There are two ways of carrying out natural mating:

(a) Flock mating

The male animal is let loose in a herd or flock. It runs with the females and detects those on heat and serves them. It is used in cattle, sheep, goats, pigs and poultry. In cattle, it results in random mating. Flock mating requires less labour.

(b) Hand mating

This is where the female on heat is brought to the male pen, thus it is also called *pen mating* . In cattle, the bull is kept under 'total confinement' and only released when the cow is observed to be on heat.

Hand mating is mainly used for servicing dairy goats and pigs. It enables the farmer to keep proper records. However, it is laborious and a farmer must be able to detect those females on heat in time which is not always possible.

Advantages of natural mating

- The male detects the female on heat and serves it on time.
- It does not require skilled personnel particularly in the administration of the service.
- The presence of a male can induce early oestrous in the females.
- There is no problem of storage facilities for semen as is the case in artificial insemination.

Disadvantages of natural mating

- It can easily spread venereal diseases such as trichomoniasis.
- In flock mating, there are risks of getting undesirable traits.
- It is difficult to keep good breeding records especially in flock mating.
- A male animal can only serve a limited stock.
- It is uneconomical to rear a bull due to high costs of maintenance.
- Large and heavy bulls can injure/crush young heifers.

2. Artificial insemination (A.I)

Artificial insemination (A.I) is the introduction of the male semen into the female reproductive tract by use of a pistolette for the purpose of serving the animal. This is mainly used by animal breeders in cattle production. It involves

two processes:

(a) Collection of semen from a bull.

(b) Insemination.

(a) Collection of semen

Semen can be collected in two ways:

(i) Females may be served while on heat or force-mated when not on heat. The semen is then withdrawn from the vagina by means of glass pipettes to be used in artificial insemination.

(ii) Use of a dummy or teasing the animal with an artificial vagina. The semen is deposited in the artificial receptacle when the dummy is mounted. It can be achieved by massaging the ampullae through the rectum. This allows semen to flow from the penis into the receptacle.

Procedure of semen collection

(i) Assemble the bull and a dam or dummy and other equipment.

(ii) Restrain the dam/dummy.

(iii) Make artificial vagina ready for semen collection.

(iv) Let the bull mount the dam/dummy.

(v) With the hand grab the penis and direct into the artificial vagina held by the other hand.

(vi) After the bull ejaculates, tilt the artificial vagina upwards for semen to fall over into the test tube.

(vii) Detach the test tube.

(viii) Take the semen for proper storage.

(ix) Release the animal(s).

Fig 8.2 (a): Artificial vagina

Fig. 8.2 (b): Semen harvest at Central Artificial Insemination Station, Kabete

The semen collected is diluted and can serve upto 10,000 cows. The semen should be stored in a deep frozen state (in special containers with liquid nitrogen at a temperature of -193°C or in solid carbon dioxide at a temperature of -79°C).

(b) Insemination

This is the introduction of semen into the female reproductive tract. The semen is placed in the vagina as close as possible to the cervix. This process requires a skilled operator.

Advantages of artificial insemination

1. Semen from high quality sires can be made available at a very low price to many farmers over a wide geographical area.
2. A genetically superior bull can serve very many cows, about 10,000 per year. Many cows can be served from a single ejaculation.
3. Ability to control sexually transmitted diseases. This is because only healthy bulls are used for semen harvesting.
4. It enables a farmer to use semen from different breeds to help improve the herd.
5. It helps in controlling inbreeding in livestock.
6. It is very economical, especially to small scale farmers, as it is cheaper to pay for A.I services than to rear a bull.
7. Valuable sires that cannot serve naturally because of a physical handicap such as age, size or lameness may still be made use of.
8. Desirable traits of a bull can still be used long after death of the bull if its semen had been stored.

Disadvantages of artificial insemination

1. Collecting, storing and administering semen is labour intensive and time consuming.
2. Adminstering A.I. requires trained personnel and special equipment.
3. It can be disastrous to the farmers if semen from inferior bulls are accidentally distributed for use.
4. It is not feasible in areas which are not easily accessible by the A.I officers.
5. Poor detection of oestrus and timing of insemination by the farmer may lead to failures in administering A.I.

Note: The success of AI administration depends on the following:

- The ability of the farmer to detect animals on heat in time.
- The availability of the inseminator at the time when the animal is due for service.

3. Embryo transplant/transfer

This is a new technique in cattle breeding that involves transplanting of a fertilized egg (zygote), resulting from mating a superior female by a superior male, into the uterus of an inferior female. The inferior female may be infertile or may produce offsprings with undesirable qualities.

The reproductive function in animals can be controlled by the following artificial means:

- Induction of ovulation.
- The development of egg transplants.

• Induction of ovulation (oestrus synchronization)

A basic requirement for ova transplants is the necessity for both the donor and the recipient cows to be at the same stage of the oestrus cycle when the transplant is done. The donor cow produces ova for fertilization while the recipient cow receives the transplanted embryo. Hormones are used to super-ovulate the donor cow. If the hormones work and the cow produces multiple eggs, all the eggs are fertilized, removed and transplanted to recipient cows. The donor cow can continue to be used only as a donor, or it can be allowed to be in-calf simultaneously with the recipient cows.

Super-ovulation is the process of inducing a cow to ovulate several ova at

oestrus through administration of **prostaglandin** or **gonadotropin** hormones. The hormonal preparations are given intramuscularly or sub-cutaneously. This stimulates the follicle-stimulating hormone (FSH) which causes the recipient animal to come into oestrus about 5 days after the hormonal injection. The hormonal preparation is administered to the animal for 5 days continuously. When the cow comes to oestrus, it is served using Artificial Insemination (AI).

• The development of egg transplants

After insemination of the super-ovulated cow, the zygotes develop. Between 6-9 days after insemination, the embryos will have distinct growth features and be ready for implantation in the uterus. They are then removed and transplanted in the recipient cow(s).

Embryo transplant techniques

There are two techniques of embryo transfer:

(a) The surgical method.

(b) Non-surgical method.

(a) The surgical method

This was used during the formative years of the embryo transplant invention technique but it is no longer popular.

(b) Non-surgical method

The procedure is as follows:

(i) The embryos are removed by flooding the uterus with a liquid media.

(ii) The uterus is then massaged to dislodge the embryos from the uterine lumen to flow out with the solution.

(iii) The solution containing the embryos is then withdrawn by use of a tube to a syringe. The syringe is taken to a laboratory where the fertilized ova are selected and separated under a high powered microscope.

(iv) The recipient cow is then restrained, anaesthetized and shaved on the area of operation. An incision is then made in the left flank allowing the horn of the uterus to be pulled out to the surface.

(v) The zygote (fertilized ovum) is then inserted into the uterus using a syringe/pipette. The syringe is inserted through a tiny hole in the uterine wall. Then the pipette is checked under microscope to ensure that the transplant is complete.

(vi) Once the transfer is complete, the uterine horn is retracted to its position, the incision sutured and the cow released. Pregnancy then progresses in the normal manner.

> **Note:** Embryo transplant technique is mostly used in experimental animals in the laboratory and rarely on farm animals. Its success rate depends on the degree of synchrony between the recipient and donor animal's site of transfer. For instance, current research shows that out of 10 embryos transferred from a single fertilized donor cow, the success rate is 4 - 6 pregnant recipient cows. The success of the technique will however, depend on skillful management.

Requirements for successful embryo transfer

- The ability to obtain a large number of embryos at a determined stage of development from the donor animal.
- Effective method of collection of embryos.
- Effective technique of transfer to the recipient animal.
- Proper storage of embryos ensuring minimal loss of vitality.

Advantages of embryo transplant

- It is possible to get a large number of ova (eggs) from a cow with desirable qualities to be implanted into cows with less desirable traits.
- It enables farmers to make maximum use of top-quality cows.
- It speeds up the breeding process.
- Makes it possible to use inferior females as surrogate mothers.

Disadvantages of embryo transplant

- It is very expensive.
- It requires skillful knowledge.
- It is laborious.

Characteristics of livestock to be selected for breeding

Selection of dairy cattle

(i) Productivity

Choose according to the production records of individual cows such as yield of milk per lactation period, butter fat content and length of lactation period.

(ii) Body conformation

The dairy cow must have a lean body. A typical dairy cow is slightly wedge-shaped (triangular shaped) when viewed from the side, from above and from the front. If viewed from the side, a dairy cow should be seen to have a greater depth of body at its hind quarters than at the front quarters. The cow should have a large heart girth. Top view (aerial) of a dairy cow should show wide hindquarters and comparatively narrow front quarters.

Neck: This should be long, lean and should blend smoothly into shoulders, clean cut dewlap, throat and brisket.

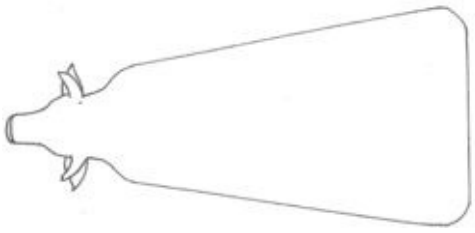


Fig 8.3: Top view of a dairy cow

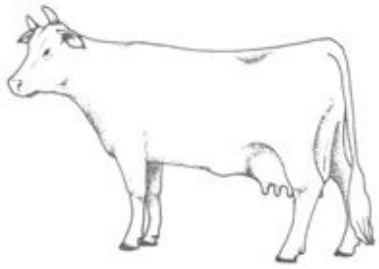


Fig 8.4: Side view of a dairy cow

- *Head:* Should have broad and moderately dished forehead. The muzzle should be broad with large nostrils. Top line should be straight with protruding pin bone.
- *Legs and feet:* Pasterns should be short and strong; hocks should have slight curve; hind legs should be well set apart, straight and strong. The fore legs should be straight and medium in length. The feet should be short, compact and well rounded with deep heel and level sole. The thighs should be wide apart from the rear view, providing ample room for the udder and its rear attachment.

- *Barrel:* This should be strongly supported, long and deep, ribs well sprung, depth and width of the barrel tending to increase towards the rear.
- *Heart girth:* This should be large and deep with well-sprung fore ribs blending into the shoulders.
- *Udder:* This should be firmly set, large and symmetrical with a moderate cleavage between the two halves of the udder. It should be soft, pliable, and well-collapsed after milking. The quarters should be evenly spaced and have fine skin. The bottom part should be level and strongly attached.
- *Teats:* These should be four, of uniform size, medium in length, cylindrical, squarely placed under each quarter (good teat placement). They should have ease of milking (not hard teats).
- *Milk veins:* These should be large, long and branching and conspicuous on either side of flanks of lactating cows.

(iii) Adaptability to the environment

Choose breeds that are well adapted to a particular environment.

(iv) Health

Use health records to select those animals which have been less affected by prevalent environmental diseases. Animals suspected of hereditary diseases should be left out.

(v) Physical defects

Leave out animals with physical defects such as lame, cryptorchid (undescended testes) and gummers (no teeth).

(vi) Dairy temperament

Select animals with good dairy temperament. Docility is preferred, that is, docile animals are easy to handle.

Selection of beef cattle

(i) Body conformation

Beef cattle should have rectangular or blocky/square body shape with relatively heavier hind quarters. The body should be low set and compact, have great width and depth throughout, with all parts smoothly blended together. The animal should be thickly and evenly fleshed. The legs should be straight, short and squarely set. The brisket should be wide and protruding forward.

(ii) Maturity

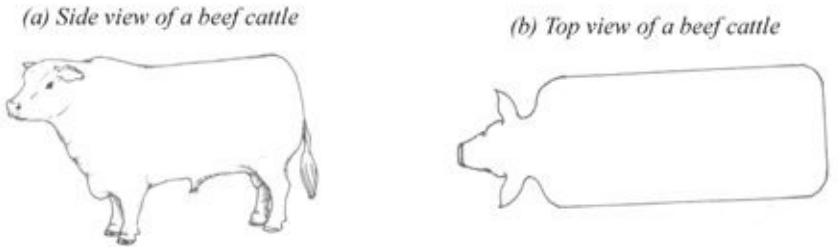


Fig 8.5: Beef cattle body conformation

They should have rapid growth rate and reach slaughter weight early.

(iii) Productivity

- Consider the carcass quality, that is, the juiciness of the beef.
- Select animals that show good meat marbling, that is, uniform distribution of fat in the meat. However, this can only be detected when an animal has been slaughtered.
- Consider the kill out percentage of the animal.

$$\text{Kill out percentage} = \frac{\text{Dressed weight}}{\text{Live weight}} \times 100$$

Average kill out percentage should be over 60%.

(iv) Reproductive traits

Mothering ability, calving interval, among others. Good beef animals should calve once a year.

(v) Health of the animal

Select animals resistant to prevalent diseases particularly those with good health records.

(vi) Adaptability to the environment

Select animals which are tolerant to the prevailing environmental conditions.

Selection of sheep

Sheep for breeding should be selected based on the following criteria:

(i) Reproductivity

Refer to the breeding records of the ancestors. Important information includes:

- Fertility - This is shown by early lambing. Sheep with high lambing percentage should be chosen.
- Mothering ability and the lambs growth rate - The lambs should have an ability to gain high live weight before weaning. Consider those with twinning ability. Choose those that exhibit fast growth.

(ii) Productivity

- Wool quality – clean fleece with long staple length and high fleece weight.
- High carcass quality such as high kill-out percentage.

(iii) Body conformation and type

For mutton sheep, they should have a blocky, compact body conformation which is low set with a straight top line and underline. The legs should be strong with short and straight pasterns. Open faced ewes produce more and heavier lambs.

(iv) Physical defects

Avoid sheep that show physical defects, such as cryptorchidism, over-shot and under-shot jaw and wool blindness.

(v) Health records

Animals with cases of frequent disease attacks should be avoided.

Selection of goats

Goats are reared in the farm for either milk (dairy goats), meat (meat goats) or mohair (Angora goats).

(i) Selection of dairy goats

A good dairy goat should be selected based on the following criteria:

(ii) Health

A nanny should be healthy, vigorous and well-grown. The signs of good health in goats include:

- Glossy and smooth coat - if the animal is unhealthy, the coat loses its glossiness, that is, staring.
- Bright and alert eyes - unhealthy animals will have dull eyes, and appear distressed and listless.

• Alertness.
• Good appetite.
• Passes out normal faeces and urine.
• Has normal body temperature of 40°C.
• Normal pulse rate of 12 -15 per minute.

(iii) Productivity

Choose a goat with a good mothering ability.

(iv) Age

Choose female goats which are less than 12 months of age.

(v) Body conformation

Should have lean forequarters, straight and strong legs, well sprung out ribs and well formed udder with good attachment both in front and at the rear. The udder should be soft to touch with two functional teats. Long pendulous udders are not desired since they are liable to tearing by thorns and mastitis attack.

(vi) Physical defects

Cull those with missing or worn out teeth. Check legs and feet for any deformities. Cull billy goats with one testis or those with swollen or undesended testicles.

Selection of meat goats

Meat goats should be selected on the following considerations:

(i) Body conformation

The body should be compact and full of flesh.

(ii) Growth rate

They should have a fast growth rate, that is, the ability to convert feed into meat and mature early.

(iii) Adaptability

They should be tolerant to prevailing environmental conditions and maintain live weight even during adverse conditions such as drought.

(iv) Fertility

They should breed regularly and have high prolificacy.

Selection of pigs

Selection of pigs for breeding stock should be based on the following:

(i) Productivity

Consider the following:

(a) Growth rate: Consider those piglets with average weight of at least 15 kgs at weaning time. Recommended growth rate is:

- At birth - average weight of 2 kgs.
- At 3 weeks - average weight of 5 - 6 kgs.
- At 8 weeks - average weight of 16 - 20 kgs.
- At 26 weeks - average weight of 100 kgs.

Choose sows whose young ones have a fast growth rate and reach maturity early.

(b) Adequate milk production for the piglets. The sow or gilt chosen should have good mothering ability. This is the ability to produce enough milk for the young ones.

(ii) Fertility

(a) **Litter size;** select those with large litter size, an average of 12-14 piglets per farrowing.

(b) **Prolific;** should have large number of offsprings during their lifetime.

(c) Should have high number of piglets weaned per litter.

(iii) Health

The animals should have no history of hereditary diseases such as hernia. They should be vigorous, have a springy tail, moist snout and warm ears. The skin should be warm and pliable, that is, not scaly or discoloured. They should show quietness, steady breathing, good appetite and produce firm dung.

(iv) Carcass quality

Pork producing pigs should have the ability to fatten during the growing period without producing an excessive amount of fat (the layer of fat on the backline should not be more than 2.5 cm thick). Bacon quality is determined by ease of curing.

(v) Temperament

The animals should show mild temperament. This is necessary at the times of servicing, farrowing and caring for the young piglets.

(vi) Physical defects

Avoid animals with any physical defects. Do not select a boar with one testicle.

(v) Maturity

Select gilts that are at least 6 -7 months old or weighing 90 - 100 kgs live weight.

(vi) Body conformation

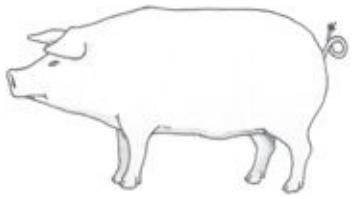


Fig. 8.6: A pig showing good body conformation

- **Pork producers** should have light head and lean neck. The back should be well arched and of ample width. The sides should be long, deep and smooth, with well developed deep hams. Straight and squarely set legs of medium length, short and strong pastern. They should also have a full heart girth, a wide chest floor, a strong back and straight, strong legs.
- **Sows**

  These should have the following desirable characteristics:
  - Good femininity.
  - A refined head (light head with clean cut jowl).
  - Smooth shoulders with firm fleshing.
  - A wide pelvis, well developed udder with at least 12 teats which are evenly spaced.
- **Boars**

  These should have the following features:
  - A light head.
  - Muscular body through the loin, rump and ham.
  - Big shoulders.
- **Bacon producers** should show good length of the sides and have less width

over the back. They should show square hams and firmness (well fleshed) throughout the body. The boar should show great masculinity such as the ability to detect females on heat.

Selection of camels

Selection of breeding camels is based on:

(i) Adaptability to environment

Camels are animals which do well in hot and dry areas. Their adaptability to these harsh conditions depends on the following characteristics:

- Ability to vary their body temperature over a wide range (34°C to 40°C).
- Ability to produce concentrated urine due to maximum water absorption by the loop of Henle in the kidney.
- Ability to drink large quantities of water at once. They have a high drinking capacity such that they can drink up to 100 litres of water within ten minutes after going for several days without it.
- Ability to feed on shrubs due to its thickened lips and long neck.
- They have localized fat deposits in the hump and thin hair on the skin to reduce heat absorption.
- Ability to produce metabolic water from stored fat in the hump when the body cells are dehydrated.
- They have a low rate of perspiration and fewer sweat glands to reduce water loss from the body.
- They have long and heavy eye lashes which protect the eye from sand blown by wind.

(ii) Productivity

This depends on the purpose for which the animal is kept that is for production of milk or meat or wool. Select parents with good mothering ability. Choose those with high quality meat such as veal from young camels.

(iii) Growth rate and maturity

Choose animals with high growth rate and early maturity (camels generally mature late).

(iv) Health

Camels with good resistance to prevalent diseases are preferred.

(v) Fertility

Select animals which breed regularly.

Livestock breeding systems

There are a number of breeding systems that can be used in livestock improvement, three of which are discussed below.

(a) Inbreeding

Inbreeding is defined as the mating of individuals who are closely related than the average relationships of all individuals in a population.

Examples:

- A brother and a sister.
- Half-brother and half sister.
- A son and a mother.
- A father and a daughter.

The level of inbreeding depends on the closeness of the relationship between the parents. This system should, only be used by breeders and not ordinary or inexperienced farmers due to the undesirable characteristics which arise in the inbred offsprings.

Advantages

- It concentrates desirable genes and retains known merits within a population.
- It helps expose undesirable recessive genes early within a herd so that such animals may be culled.
- It promotes uniformity in a population.
- It is useful in testing male animals for abnormalities, that is, testing whether they are carriers of hereditary defects.

Disadvantages

- It leads to weak, inferior animals by concentrating too many recessive gene pairs in the progeny. Recessive gene pairs expression may result in cryptorchidism, low fertility and high embryonic mortality.
- There is reduced performance in the animal (that is, inbreeding depression).
- There is reduction in vitality.

(b) Cross breeding

This is the mating of two animals belonging to different breeds or grades.

Examples: Friesian bull and Zebu cow.
Hereford bull and Aberdeen Angus cow.
Large White boar and Landrace sow.
White Leghorn and Hampshire Red.

Advantages

- The crossbred offspring has an average performance midway between the parent breeds. The first crossed animals usually exhibit hybrid vigour.
- It increases heterozygosity in all crossbred offsprings hence improving the quality, that is, introduces new gene pool into the herd.
- Crossbred animals can adapt better to harsh environments.
- It helps in pooling of several important gene characteristics found separately in two different breeds (parents).

Disadvantages

- Obtaining semen from pure breeds for use in cross-breeding is very expensive to most farmers.
- Certain desirable traits in a family of animals are broken up.
- It is not possible for a farmer to know at what stage of cross each animal is.

(c) Out-breeding

This is the mating of unrelated pure bred animals within the same breed. It involves mating bulls with the cows of the same breed. The success of this system depends on how well the two strains to complement each other when they are brought together. It is commonly used in dairy cattle. For example, mating a Holstein Friesian bull with a British Friesian cow. The offspring of such a mating is known as an outcross.

Advantages

1. Results in genetic improvement which enhances vigour.
2. The method is suitable for beginners in breeding.
3. It brings desirable traits into the herd by overshadowing undesirable traits that are already present.

Disadvantage

It is expensive to import semen for individual farmers.

Practical Activity 8.1

1. Visit a farm neighboring the school and learn how farmers select breeding animals.
2. Visit a farm using artificial insemination (A.I) method of service and study more about A.I services.

Revision Exercise 8

1. Define the term selection.
2. How would you select a good dairy cow using physical appearance?
3. What do you understand by the following terms:
   (a) Heterosis.
   (b) Epistasis.
4. State the disadvantages of inbreeding.
5. What are the main disadvantages of artificial insemination?
6. Explain how embryo transplant is done.

Topic 4

Agricultural Marketing

Unit 9: Trading of agricultural commodities

Unit 9 Trading of Agricultural Commodities

Specific objectives

By the end of this unit, you should be able to:

(a) Distinguish between marketing and trading.

(b) Explain the importance of trading agricultural commodities.

(c) Outline ways of improving trading of agricultural commodities.

Introduction

No country or individual can be able to produce all what would be required. It therefore has to buy commodities from other farmers, communities or countries. This means there is exchange of agricultural commodities between individual farmers, communities and even nations. This unit deals with exchange of agricultural commodities.

Marketing and trading

Agricultural production is only complete when the products reach the consumers. There are several individuals or agents who buy agricultural commodities and sell them at a profit. This is called **trading.** Trading simply means buying commodities and then selling them at a profit.

Marketing refers to all the processes involved in the transformation and flow of goods and services from the producer to the consumer. It encompasses creating awareness of existence of such goods and services among the consumers and facilitating the availability of the goods in an acceptable form. The processes involved in the marketing are known as **market functions.**

Market functions include:

(i) Buying and assembling.

(ii) Selling.

(iii) Transport and distribution.
(iv) Packing.
(v) Storage.
(vi) Processing.
(vii) Grading and standardization.
(viii) Advertisement.
(ix) Packing.
(x) Collection of market information.
(xi) Financing the market functions.
(xii) Risk bearing.

Differences between marketing and trading

Marketing	Trading
1. Concerned mainly with the satisfaction of the consumer.	1. Concerned mainly with the total sales.
2. Involves numerous processes hence very wide.	2. Involves only buying and selling hence not wide.
3. Produces after thorough research to determine what the consumer wants.	3. Uses resources to buy and then sell at a profit.
4. Produces to the market demand and make some profit.	4. Aims at making profit by disposing any surplus commodity.

Importance of trading of agricultural commodities

Trading of agricultural commodities can be carried out at different levels namely:

(a) Community level trade.
(b) National level trade.
(c) Foreign/international level trade.

Trading at community level

This is carried out by small scale traders, usually retailers and wholesalers. Retailers buy agricultural commodities from wholesalers and later sell them to

the consumers in affordable units for example, roadside sellers and itinerant traders. Wholesalers buy agricultural commodities from the processers or straight from the farms and sell them to retailers in small quantities. Both the retailers and wholesalers deal with a variety of agricultural commodities. Trade at community level also involves on-farm buying where consumers buy directly from their neighbour farmers. Agricultural commodities like fruits, vegetables and livestock products are some of the produce that can be traded at community level.

Fig. 9.1: Women selling agricultural commodities in the market

Importance of trade at community level

- Provides an outlet for excess produce from farm holdings in the community.
- Promotes efficient division of labour within the community.
- Encourage members of the community to engage in enterprises that are rewarding to them.
- Members of the community can buy more goods from the income they earn.
- Increases productivity of the community.
- Promotes specialisation.
- Improves the living standards of the community members.

Trading at national level

This trade is carried out within the boarders of a country but at a higher level

than the community trade. It involves transportation of the commodities from areas of production to areas where they are scarce, usually from the rural areas to urban areas. The traders may also own large scale storage structures for grains. Trading at national level requires high level of investment.

Importance of trade at national level

- It ensures availability of a variety of commodities in the country.
- A country is able to get commodities that it does not produce.
- It creates and promotes understanding among various communities in the country.
- It promotes specialisation.
- It enables the producers to dispose surplus produce.

Fig. 9.2: Truck transporting bagged goods

- It ensures steady supply of various agricultural commodities.
- It creates employment opportunities.
- The government and traders earn revenue.
- It enables urban population to get food.
- It promotes agricultural allied industries such as agro-chemicals manufacturers, farm tools and equipment dealers, and processors dealing with agricultural commodities.

Trading at international level

The international trade is carried outside the boundaries of a country.
International trade can be classified into two:

(a) ***Bilateral trade*** **;** this is trade between two countries.

(b) ***Multi-lateral trade*** **;** this is trade among many countries.

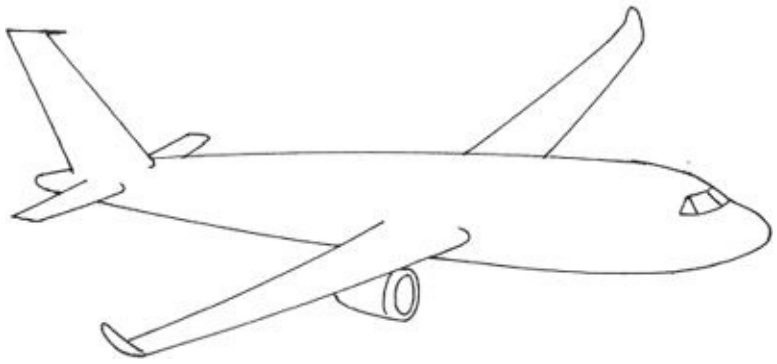


Fig. 9.3: Aeroplane transporting horticultural produce/flowers

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 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.
- The country earns foreign exchange.
- It improves international relations.
- It widens the market for the country's agricultural commodities.
- It has higher chances of getting humanitarian aid from the trade partners in case of a calamity.
- It improves the country's transportation and communication facilities.
- It improves the living standards of the citizens of the country.
- It encourages specialization in particular agricultural commodities.

Problems associated with international trade

- It hampers infant industries due to unfair competition from cheap imports.
- Some harmful or unsuitable commodities may be imported for example weeds, diseases, crop varieties and many others.
- Incase 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 to over-relying on rich partners of trade.
- Members of a 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) Harmonise taxation; this ensures that the traders are not overtaxed.

Improving trading of agricultural commodities

(a) Community level

- Ensure rural roads are passable even during the rainy season. This creates easy and quick access to the agricultural commodities produced in that area.
- Promoting the development of rural growth centres that act as trading centres for a particular area.
- Promote peaceful and harmonious co-existence among the neighbouring communities.
- Promote communication facilities, for example, radio, TV and telephones especially mobile telephonies. This eases access to valuable market information.

(b) National level

- Improve transport infrastructure for example roads, railways, airways and water ways. These will ease and fasten transport of agricultural commodities.
- Improve communication facilities.

- Promote political stability to ensure peace and tranquility; this allows the citizens to go about their daily business without fear.
- Provide adequate market information on major agricultural commodities.
- Establish buffer stocks in case of overproduction and then release it in time of scarcity. This helps to reduce price fluctuation.
- Harmonise taxation; this ensures that the traders are not overtaxed.

(c) International level

- Improve transport facilities at national level and international level (airport transport). This ensures perishable agricultural comodities reach the market on time and when still fresh.
- Promote good international relations such that nationals of member countries freely interact.
- Remove trade barriers.
- Ensure easy access to international market information by potential exporters and importers.
- Promote information communication and technology (ICT) that would greatly enhance e-commerce.
- Promote production of high quality agricultural commodities that is with low levels of chemical residual.
- Improve advertisement through export and promotion of government agencies.
- Encourage production of a variety of agricultural commodities.

Practical Activity 9.1

- Visit an open air market and identify some of the agricultural commodities traded there.

Revision Exercise 9

1 . Define the following terms:
   (a) Trade.
   (b) Marketing.
2 . Give three differences between marketing and trading.
3 . Explain four importances of trading agricultural produce at the following

levels:

(a) International level.

(b) National level.

4 . What are the problems associated with international trade?

5 . List four ways of improving trading of agricultural produce at:

(a) Commodity level.

(b) National level.

(c) International level.

Topic 5

Farm Business Management

Unit 10: Farm Budgeting

Unit 11: Agricultural Co-operatives

Unit 10 Farm Budgeting

Specific objectives

By the end of this unit, you should be able to:

(a) Name types of farm budgets.

(b) Differentiate between partial and complete budget.

(c) Prepare complete and partial budgets.

Introduction

Farming, like any other business, requires prior planning for available resources. This calls for estimating of the expected expenses and to some extent predict the expected outcome. This unit deals with commonly used types of farm budgets.

A **budget** is an estimate of the future expenses and income of a proposed farm plan. Budgeting is the process of estimating the results of a proposed farm plan. It is the translation of a physical plan into financial terms.

Types of budgets

There are two types of farm budgets that is, partial budget and complete budget.

Partial budget

This is the simplest form of a farm budget. It shows the financial implications of proposed minor changes in the farm, that is, increasing a particular enterprise at the expense of another, or a change of the production technique. A partial budget helps to determine whether the proposed change is worthwhile.

In partial budgeting there are four questions which guide a farmer in determining the profitability of the proposed change. These questions are:

(i) *What extra revenue (ER) can be expected?*

(ii) *What extra cost (EC) will be incurred?*

(iii) *What present costs will no longer be incurred? that is costs saved (CS) .*

(iv) *What present revenue will be foregone? that is revenue foregone (RF) .*

Total gains = Extra revenue + Costs saved.

Total costs = Extra costs + Revenue foregone.

Net gain/loss = Total gains − Total costs.

If the net gain is positive, the proposed change is worthwhile. If the net gain is negative then it is not advisable to implement the proposed change.

Example:

A farmer intends to increase her dairy herd from 4 to 6 cows. Considering the following specifications, determine whether the change is profitable.

The acreage under maize is reduced by one hectare to cater for the two extra cows. Each cow requires the purchase of a replacement heifer each year at MK. 6 000, while the cull price per cow is MK. 4 000. Milk yield for each cow is 3 000 kg per year, price of milk is MK. 40 per kg. Each cow gives birth to a calf worth MK. 1 000 every year. Veterinary service charge per cow is MK. l 200 per year, while the cost of concentrates and minerals per cow is MK. 720 per year. The seedbed preparation cost for maize production is MK. 3 000 per ha. Planting and fertilizer cost of maize are MK. 1 000 per ha and 5 400 per ha respectively. Pest control cost for stalkborer is MK. 600 per ha, weeding cost is MK. 1 200 per ha, while the cost of harvesting maize is MK. 1 200 per ha. Gunny bags for packing maize are purchased at MK. 80 each. Maize yield is 40 bags per ha, and the maize price is MK. 1 600 per bag.

Partial budget

Debit (–)		Credit (+)	
Extra costs	MK.	**Cost saved**	MK.
Replacement heifer		Maize production	
6000 × 2	12 000	Seed bed preparation	3 500
Concentrate and minerals		Planting @ 1000 MK.	1 000
720 × 2 =	1 440	Fertilizer @ 5400 MK.	5 400
Veterinary charges		Stalk borer dust @ 600 MK.	600
1200 × 2	2 400	Weeding costs	1 200
Revenue foregone		Harvesting costs	1 200
Income from maize		Gunny bags	
@ MK. 1600 × 40 bags	64 000	@ 80 MK. × 40 bags	3 200
		Extra revenue	
		Sale of milk:	
		6000 × 2 @ MK. 40	240 000
		Sale of extra calves	
		MK.1000 × 2	2 000
		Cull price @ 4000 × 2	8 000
	79 840		266 100

Extra revenue = 266,100 - 79, 840

= 186,260

Under the specifications above, it is profitable to implement the proposed change. The farmer will make an extra revenue of MK. 186 260.

Complete budget

When proposed changes in the farm are major or a new farm is being planned for, a complete budget is mandatory. Unlike the partial budget which only deals with variable inputs, a complete budget considers both variable and fixed inputs.

Guidelines to follow when carrying out complete budgeting

1. Formulate goals and objectives.
2. Take inventory of the farm. Include all assets present in the farm.
3. Plan for various resources, for example, how land, labour and capital are to be utilised.

4. Estimate income and expenditure. A statement of income and expenditure is drawn using current costs and prices.
5. Analyse the input; output relationship that may exist in the farm.
6. Draw alternative farm plans. Choose one of the plans for adoption.
7. Implement the chosen plan.
8. Evaluate the plan; In the course of production, a farmer evaluates the plan to determine and improve on its weaknesses.

Complete budget for maize on a 2 hectare piece of land

Item	Unit	Price/ cost per unit (MK)	Quantity	Value (MK)	Total cost (MK)	Cost/ (MK)
Receipts						
Sale of crop	90 kg bag	2 725	48		130 800	
Sale of maize					20 000	
Stalks for fodder	1 hectare	10 000	2			
Total receipts					**150 800**	
Variable costs						
Seeds	1 kg	800	44		35 200	17 600
Fertiliser						
• Nitrogenous	50 kg bag	5 000	4		20 000	10 000
• Phospahatic	50 kg bag	4 000	3		12 000	6 000
Chemicals						
• Pesticides	1 kg	600	2		1 200	600
Tractor hire	hectare	16 000	2		32 000	16 000
Casual labour	man/day	200	50		10 000	5 000
Miscellaneous					10 000	5 000
Total variable cost					**120 400**	
Fixed costs						
Permanent labour	man/month	20 000	2		40 000	20 000
Utilities						
• Water	meter/month	1 700	12 months		20 400	
• Electricity	meter/month	2 500	12 months		30 000	
Management charges	month	30 000	12 months		360 000	
Total fixed costs					**450 400**	

Difference between partial and complete budget

Partial budget	Complete budget
l. Drawn when minor changes are proposed on the farm, for example, expansion of existing enterprise.	l. Drawn when major changes are proposed on the farm, for example, starting a new farm business.
2. Considers only variable costs.	2. Considers both variable and fixed costs.

Practical Activity 10.1

1. Visit a farm and get information from the farm manager on farm budgeting.
2. Visit a farm and obtain information from the farm records to prepare a partial budget

Revision Exercise 10

1. Define the term budget.
2. Differentiate between partial budget and complete budget.
3. List four importances of farm budgeting.
4. State two instances when a partial budget can be drawn.
5. Give four guideline question in preparing a partial budget.
6. A farmer intends to grow cotton on a newly broken 3 ha land. Given the following specifications and prescriptions, determine whether the proposal is worthwhile.
   - From prior knowledge, casual labour for cotton is 200 man/days/ha @ MK 180, however, the farmer intends to replace casual labour with a tractor @ MK 20,000/ha.
   - Use of the tractor is expected to increase cotton yield from 800 kg/ha to 1000 kg/ha seed cotton.
   - Price of cotton is MK 110/kg.
   - Cost of harvesting cotton is MK 400 per 100 kg seed cotton.

Unit 11 Agricultural Co-operatives

Specific objectives

By the end of this unit, you should be able to:

(a) Explain the meaning of the term ‘agricultural co-operative’.

(b) Explain the importance of agricultural co-operatives.

(c) Identify principles for co-operative formation.

Introduction

Marketing of agricultural produce is one of the most challenging part of agricultural production. Small holder farmers in Malawi do not have adequate capital to carry out most of the marketing functions. They stand prone to exploitation by middlemen. Farmer co-operatives can help alleviate this problem among others.

Meaning of the term agricultural co-operative

An agricultural co-operative is a group of farmers who have come together on voluntary basis for the purpose of achieving a common goal for mutual economic benefit. The members share common interests and are willing to pool their resources together to derive much economic benefit from their organisation.

Types of farmer co-operatives

There are different types of farmer co-operatives depending on the membership and purpose for its set up. The most common types include:

- Farm production co-operatives.
- Marketing co-operatives.
- Consumer or distribution co-operatives.
- Savings and Credit Co-operatives.

(i) Farm Production Co-operatives

These are co-operatives that deal mainly with the actual production of particular crops or with livestock keeping. Members usually work on the farm as a group. At the end of production and marketing, the members share the profit. The members may have small plots within the main farm for their own domestic use.

The main objective of the farm production co-operatives is to exploit the economies of scale through large-scale production.

(ii) Marketing Co-operatives

These are co-operatives that undertake the responsibilities of collection, processing and selling of farm produce. The individual farmers carry out the production and bring their produce together so as to transport and process as a group. This reduces operational costs, for example, National Small Holders Farmers Association of Malawi (NASFAM).

(iii) Consumer Co-operatives

These are co-operatives which deal primarily with farm inputs. They buy inputs in bulk and then sell to members at subsidised prices. These co-operatives may also offer marketing services to their members.

(iv) Savings and Credit Co-operatives (SACCO)

These co-operatives encourage their members to save their earnings and later provide them with loan facilities. The loan given is always proportional to one's savings but they attract relatively low interest rates compared to commercial banks. Most co-operative societies also offer savings and credit services. There are many SACCOS in the country registered under Malawi Union of Savings and Credit Co-operative Organisation (MUSCCO) which is the umbrella body for all SACCOS.

Structure of co-operative movement

There is a clear hierarchy of co-operative movement from local level to international level. There are four structural levels of co-operatives namely:

- Primary level.
- Secondary level.
- National level.
- International level.

1. Primary level co-operatives

They are co-operatives formed by individuals who join the co-operatives on individual capacity. The members are attracted by a certain factor such as production or trade in same produce or service provision within the same locality. They are usually referred to as co-operative societies.

2. Secondary co-operatives

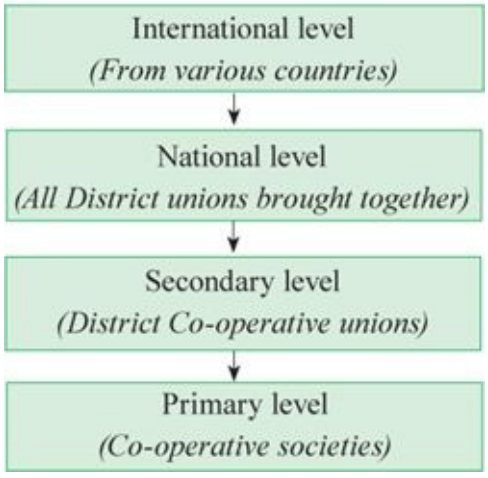
They are formed by individual co-operative societies which draw their membership from co-operative societies but not individual persons. An example is the District Farmers Co-operative Unions.

3. National co-operatives

These are mostly formed by individual co-operative unions found countrywide.

4. International co-operatives

These are formed by national co-operatives of various individual countries. They are normally trade blocs dealing with particular products.



Formation of co-operatives

When a group of individuals have agreed that there is need for them to come together to form a co-operative, they seek for registration. The legal procedure of forming and registering a co-operative is as follows:

(i) Minimum number of eligible persons to form a co-operative is ten.

(ii) Elect an interim committee.

(iii) Draft the co-operative's rules and by-laws (co-operative constitution).

(iv) Articulate the objectives of the co-operative.

(v) Suggest a name for the co-operative.

(vi) Apply for registration to the relevant agricultural authorities.

A co-operative Society is basically made up of:

(i) Members of the society who pay a membership fee.

(ii) Committee:This is a group of members elected by other members. The committee manages the co-operative society.

(iii) Executive staff:These are employees of the co-operative society. They implement the decisions of the committee.

Functions of co-operatives

- Carry out all marketing functions on behalf of the farmers.
- Provide short-term credit facilities to their members. This may be in terms of inputs or cash loans payable by the end of the production period.
- Negotiate for fair prices for both input purchase and sale of farmers produce.
- Distribution of farm inputs to their members.
- Provide extension services and machinery hire services to their members.
- Advise their members on new and better methods of production.
- Keep records on all activities of the co-operative and inform the members accordingly during annual general meetings.
- Pay dividends to their members.
- Some provide banking services to their members.
- Some invest money on behalf of the farmers.

Principles of co-operatives

Formation and running of co-operatives is governed by several principles. These principles include:

- Open membership, there is free entry and exit.
- Run on democratic principles, “one member one vote”.
- Does not allow voting by proxy.
- There is a share limit that cannot be exceeded.
- Have a non-profit motive.
- Members should remain loyal.
- Members sell their produce through the co-operative.

• Neutrality in religion and politics.
• Should continuously educate its members.
• Should join from the local to the national level.

Practical Activity 11.1

Visit an agricultural co-operative and find out:
(a) The roles they play to their members.
(b) Principles that guide the formation of co-operatives.

Revision Exercise 11

1. Define the term agricultural co-operative.
2. Outline the benefits a farmer gets by being a member of an agricultural co-operatives.
3. Outline the principles that govern the formation of co-operatives.
4. Name two types of co-operatives.

Topic 6

Agricultural Technology

Unit 12: Farm Mechanisation

Unit 12 Farm Mechanisation

Specific objectives

By the end of this unit, you should be able to:

(a) Give the meaning of the term ‘farm mechanisation’.

(b) State the advantages and disadvantages of farm mechanisation.

(c) List types of implements and farm machinery.

(d) Describe the maintenance of various farm machinery.

(e) Maintain various types of farm machinery.

(f) Identify safety measures when using farm machinery.

(g) Observe safety measures when using farm machinery.

(h) Explain the factors to consider when mechanising a farm.

Introduction

Mechanisation of agriculture helps in increasing production, productivity and profitability by achieving timelines in farm operations. Most of the small scale farmers in Malawi use simple hand tools to carry out most farm operations. This has its limitations. Current mechanicalized agriculture in the developed countries includes use of airplanes, helicopters, trucks and tractors among other vehicles. Modern farms even sometimes use computers in conjunction with satellite imagery and GPS guidance to increase yields. Malawi has good rains and abundant water reservoirs, and with mechanization it is possible to double crop yields within a short period of time.

What is farm mechanisation?

Farm mechanisation refers to the use of power driven machinery and implements to carry out certain farming activities of agriculture. It increases farm output and farm worker productivity.

With the use of tractors, a single farm worker can harvest a crop in 10 hectares

of land in a single day.

Advantages of farm mechanisation

• Increases crop yield.
• Farm operations can be done on time.
• Improved production efficiency by reducing cost per unit of product.
• 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.
• Operations are done more efficiently.
• Substitutes expensive farm labour.
• Compensates for labour peak periods.

Disdvantages of farm mechanisation

• Redundancy of unskilled farm labour.
• Lack of capital to purchase machines and implements.
• Small land holdings make mechanization uneconomical.
• Requires skilled and qualified personnel to operate most machines.
• Highly skilled operators require higher wages.
• Mechanization leads to environmental pollution.
• May lead to deforestation and hence soil erosion.

Practical Activity 12.1

Visit a nearby mechanised farm and observe the mechanical activities.

Types of farm machinery

These are broadly classified into:
• Tractor-drawn implements.
• Animal-drawn implements.

1. Tractor-drawn implements

These are implements attached to a tractor to carry out various operations. There are many different types of tractor-drawn implements such as trailers, ploughs,

planters and mowers. Each is attached to the tractor differently depending on its design. There are three ways of attaching(hitching) an implement to a tractor. These are:

• Single point hitch (drawbar)

The attached implement has its own wheels for support and is sometimes called the pulled type of hitching. Hitch pins on the implement are used to fit the implements onto the tractor through drilled holes or eyes on the draw bar of the tractor, for example, trailers.

• Three point hitch (hydraulic system)

The implements are attached at the two side links and a top link. They are also referred to as the fully mounted or integral types. Such implements do not need other support. They are lifted from the ground by the hydraulic system.

• Power take off (P.T.O)

These are implements driven by power take off shaft or belt and pulley, which are in rotary motion. The implements are attached at the rear end of the tractor and are driven by engine power. The P.T.O may be used to operate reciprocating mowers, rotavators and sprayers.

Examples of tractor drawn implements

(a) Tractor trailer

This is a container which is pulled by a tractor and used to carry various farm produce and inputs to and from the farm. The common trailer has two wheels but larger ones have more than two wheels depending on the size of the trailer. Some can be self tipping by use of a hydraulic system.

Fig.12.1: Tractor trailer .

Maintenance of trailer

- Check tyre pressure and adjust accordingly before each day's work.
- Avoid overload.
- Lubricate the wheel bearings regularly.
- Clean the trailer regularly.
- Keep under a shed for long storage.
- Check bolts and nuts. Tighten loose nuts or bolts.
- Repair damaged parts.

(b) Tractor drawn ploughs

These are farm implements used for cultivation purposes. There are several tractor drawn ploughs. The most common are the disc plough, the mouldboard plough and the sub-soiler.

(i) Disc plough

The disc plough has 3 to 6 heavy concave discs of about 60–70 cm in diameter. The discs are mounted on a standard (hangers) and the standard is fixed onto a beam. The discs could be plain or notched at the edges. When ploughing, the discs roll cutting furrow slices and throwing them sideways.

The disc plough is more useful in stony places or in places with stumps and a lot of roots. This is because discs roll over hidden obstructions like stones and are not easily blocked by vegetation during ploughing.

The disc plough can also work easily in hard soils where it is difficult to use a mouldboard plough. However, it requires less power to pull.

Adjustments on the disc plough

- The cutting angle is adjusted by pivoting the beam or the standard to 35° or 50° from the line of travel.
- The depth of ploughing is corrected by changing the height of the depth wheel or by adjusting the hydraulic system. It is also achieved by adding more weight on the beam.

Parts of a disc plough

• *Hitch mast*

This is an attachment for the three point hitch made up of two side links and a top link. These are parts connected to the hydraulic system of a tractor for the lifting and pulling of ploughing discs.

• *The beam*

This provides attachment for all other parts of the plough and adds more weight for better plough depth penetration.

• *The discs*

They are concave in shape. They cut and invert the furrow slices. Each disc rotates independently.

• *Scrappers*

These are located close to the concave surface of the disc. It is used to remove trash and mud or soil which may cling on to the discs and interfere with penetration.

• *Depth wheel*

It is also called furrow wheel. It controls the depth of ploughing and helps in balancing the whole implement.

• *Standards /hangers*

These connect the discs to the main beam and have hubs which allow the discs to rotate.

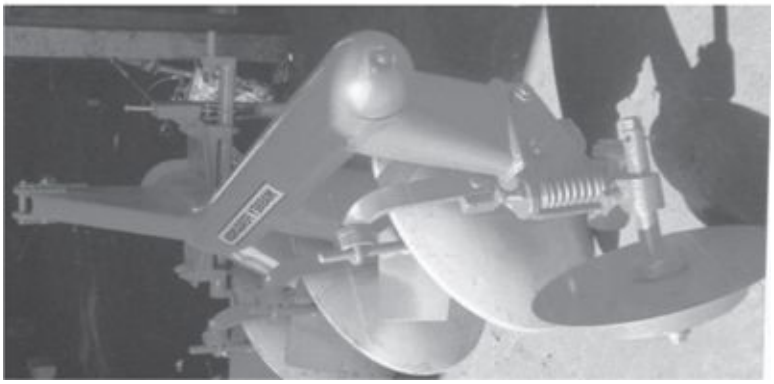


Fig.12.2 (i): Photo of a disc plough .

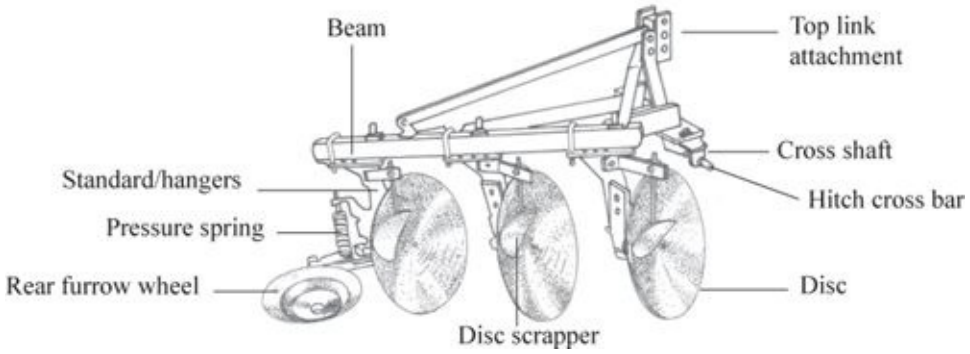


Fig. 12.2 (ii): Parts of a disc plough .

Care and maintenance

- Clean after use.
- Tighten loose nuts and bolts.
- Apply old engine oil on the plough for long storage.
- Lubricate moving parts.
- Repair damaged parts that is, weld broken discs.
- Store in a dry place.
- Replace lost or worn out parts such as nuts and scrappers.
- Sharpen discs by hammering the edges.

Advantages of using a disc plough

- Requires less power to pull as the discs have the ability to roll.
- Very effective in stony land.
- Very suitable in dry hard soils.
- Relatively low maintenance cost since the discs last long.

• Requires less skill to operate than a mouldboard plough.

Disadvantages of using a disc plough

• A high tractor speed on a piece of land leaves rough seedbed which needs more secondary tillage operations. This may be very costly.
• Depth of ploughing is uneven as penetration depends on the hardness of the soil or presence of obstacles.

(ii) Mouldboard plough

Mouldboard plough is used in soft soils and it cuts the soil and turns the slice upside down burying surface trash completely.

Parts of a mouldboard plough

• ***Share***

Makes horizontal cut in the soil and initiates inversion of the furrow slice.

• ***Mouldboard***

Inverts furrow slices thus covering surface vegetation completely.

• ***Landside***

Stabilises the plough and absorbs the side forces created when furrow slice is turned.

• ***Disc coulter***

Makes a vertical cut into the soil to separate the furrow slices from the unploughed land. It also helps to cut the trash which may prevent the share from going deep into the ground.

• ***Skim coulter***

Removes any trash from between the furrow slices.

• ***Frog***

It connects the share, mouldboard and the landside to the frame.

• ***Heel iron***

Carries the weight of the plough at the back.

• ***Tail piece***

Facilitates the turning of the furrow slice.

• ***Beam***

This is a metallic frame on which all other parts are attached. Its weight increases the penetration depth of the plough.

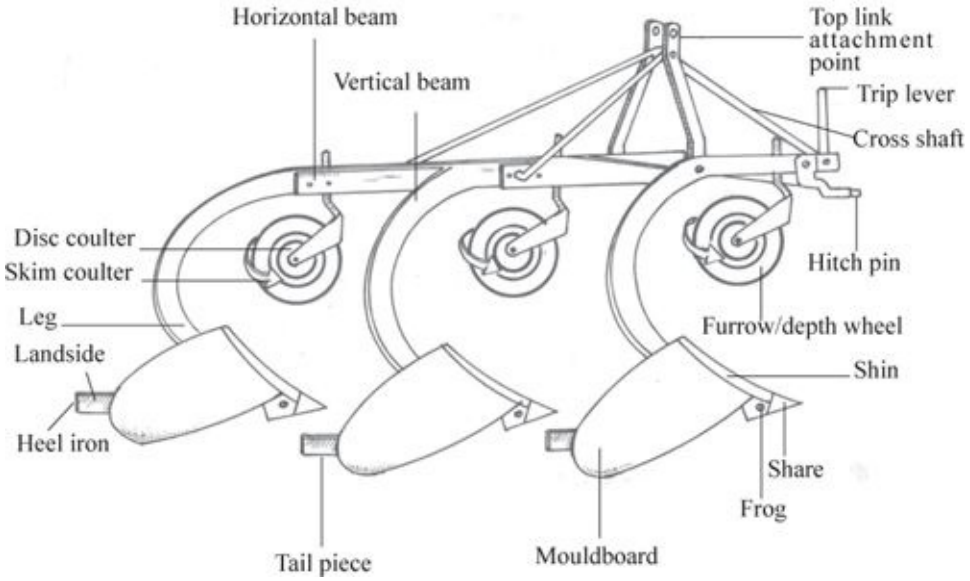


Fig.12.3: Parts of a mouldboard plough .

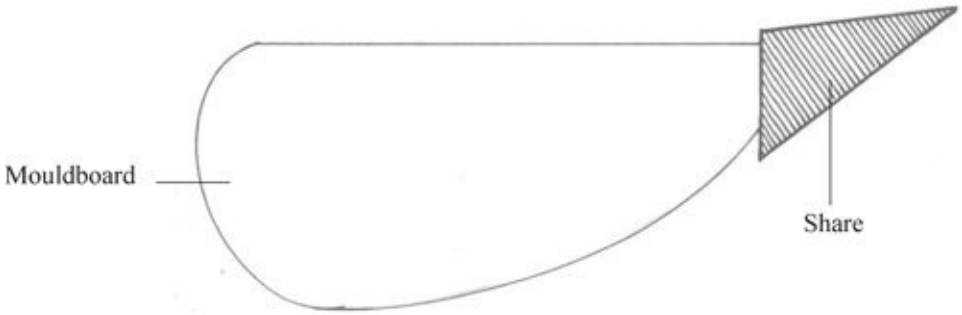


Fig.12.4: Top view of a mouldboard .

Furrow/depth wheel

Controls depth of ploughing.

Fig. 12.5: Mounted tractor-drawn mouldboard plough in use/action .

Adjustments on the mouldboard plough

- Adjust the hydraulic lever system.
- Adjust the top link. Shortening of the top link leads to shallow cultivation, while lengthening it leads to deep cultivation.
- Reduce the depth of ploughing by lowering the depth wheel in some models.
- Furrow width is controlled by cross shaft adjustment level.

Care and maintenance

This is the same as for disc ploughs.

Advantages of the mouldboard plough

- Achieves uniform depth of plough.
- Produces a relatively good and clean seedbed in one operation. This is especially in fields previously planted with annual crop.

Disadvantages of the mouldboard plough

- It is prone to damage by hidden obstacles.
- It cannot plough dry and hard soils effectively.
- It can easily create a soil hard pan as it follows the same depth throughout.
- Higher maintenance costs due to frequent replacement of shares.
- It requires higher pulling power.

Operational differences between disc and mouldboard ploughs

Disc ploughs	Mouldboard ploughs
• Discs rotate as they plough.	• Glide as they plough.
• Best suited for virgin land.	• Best suited for stubble land.
• Cut at varying depths.	• Cut at uniform depth.
• Do not break easily.	• Break easily.
• Require less power to pull.	• Require more power to pull.
• Give poor/rough seedbed surfaces in first ploughing.	• Give fairly smooth seedbed in first ploughing.
• Do not cover trash properly.	• Cover trash completely.

(iii) Subsoiler

This is the strongest and heaviest implement of the ploughs. It requires high power to pull. The digging depth ranges from 51–90 cm.

Uses

- It is preferred in cultivation of compacted soils.
- It is used to break up the hardpan within the subsoils.

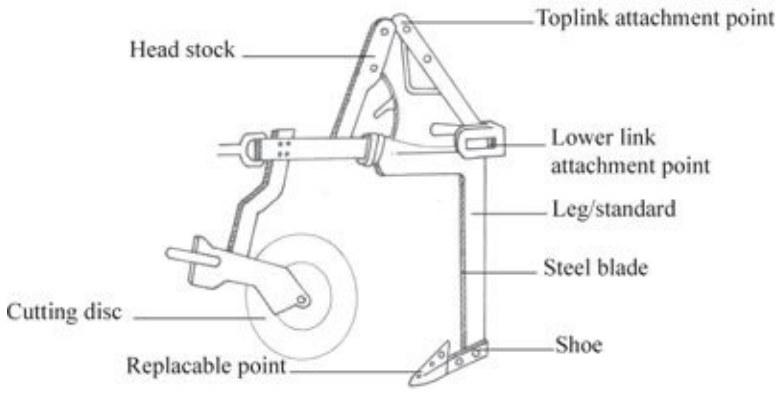


Fig.12.6: Parts of a subsoiler .

Adjustment

- Depth of ploughing is adjusted by hydraulic system or gauge wheels.
- Ploughing depth can also be adjusted by use of top link making it parallel to the ground surface.

Maintenance

(i) Clean after each day's work.

(ii) Check for worn out parts and replace.

(iii) Coat with old engine oil for long storage.

(iv) Tighten loose nuts and bolts before work begins.

(c) Harrows

These are implements used for secondary tillage operations. The main uses include:

- Levelling of seedbed.
- Breaking large soil clods.
- Mixing up soil.

• Destroying weeds.
• Covering broadcast seeds.

Types of harrows

There are several types of harrows namely:
• Disc harrows.
• Spring tined harrows.
• Spike tooth harrows.
• Zig-zag harrows.

(i) Disc harrows

These are similar to disc ploughs but their discs are smaller. The discs can be either plain or notched hence the plain disc harrows and notched disc harrows, respectively. Several discs are assembled in one shaft forming a gang or tandem. Each gang may have 4 to 8 discs. The gangs are set at a certain angle to the line of travel. The discs push soil in the opposite direction resulting in soil mixing and the harrowing effect. There are double gang disc harrows and four gang disc harrows. A gang rotates as a unit. These gangs are assembled in offset (two gangs) or in tandem (four gangs).

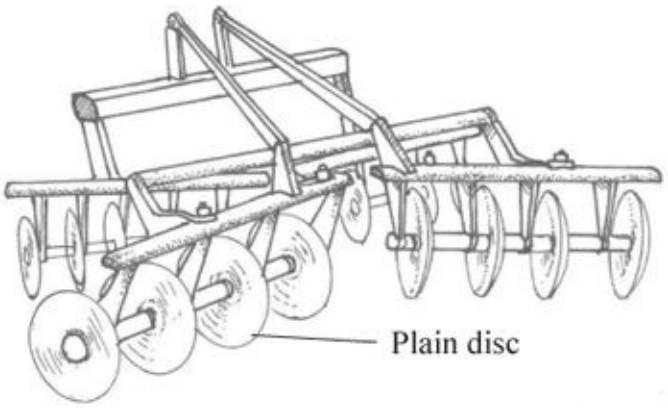


Fig.12.7: Four-gang harrow in a tandem .

Fig. 12.8: A combined notched disc and plain disc harrow ready for attachment .

Adjustment of harrowing depth

- Add weight on the harrows.
- Use the hydraulic lever system.
- Use the regulating wheels.

(ii) Spring tine harrows

These have coiled spring tines fixed on a frame. The tines vibrate as they are pulled along the ground. This vibration helps to break up soil clods as well as to level the seed bed. The vibrating motion also helps in improving soil aeration. It is effective in the removal of rhizomatous weeds from the soil for example couch grass.

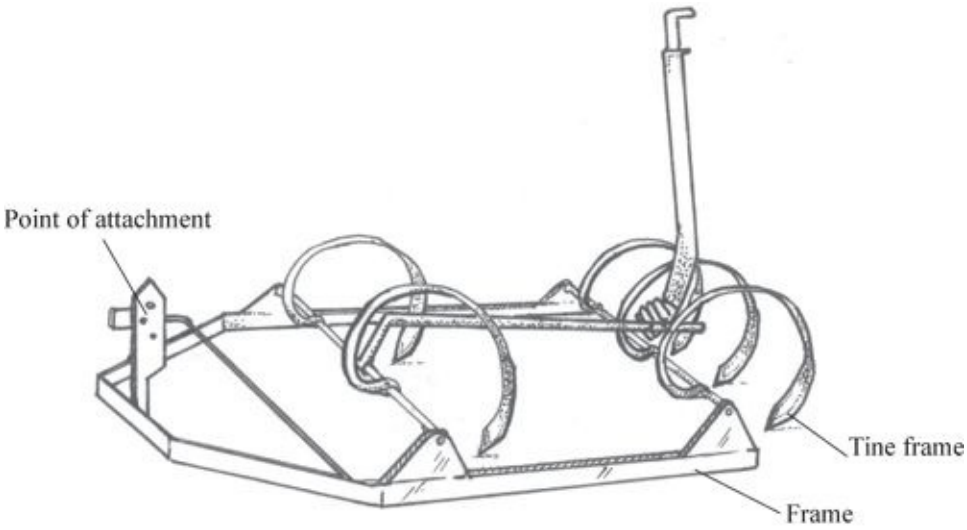


Fig.12.9: A spring tine harrow .

Fig. 12.10: Mounted spring tine cultivator ready for use .

Adjustment

Depth of harrowing is controlled by the horizontal link and depth wheel.

(iii) Rigid spike tooth harrows

These harrows have several strong pointed spikes mounted on a frame. Spike tooth harrows are used to prepare very fine and flat seedbeds as well as to incorporate fertilizers into the soil. They are also used to remove rhizomatous weeds from the soil, for example couch grass.

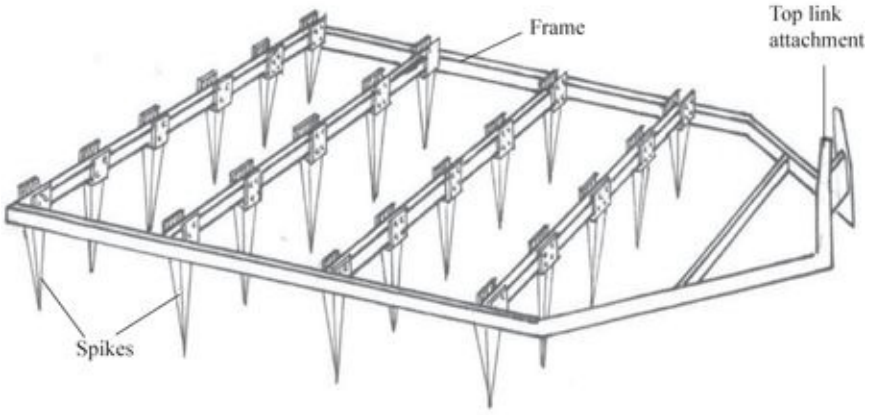


Fig. 12.11: Spike tooth harrow .

(iv) Zig zag harrows

The tines are arranged on the frame in a zig zag manner.

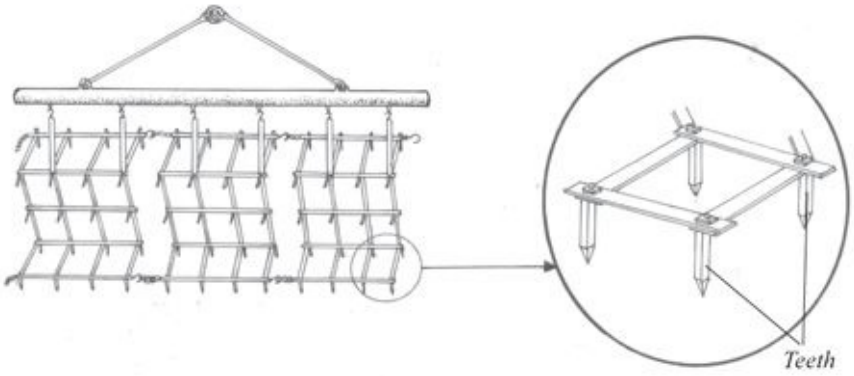


Fig. 12.12: Zig zag harrow .

Maintenance of harrows

- Clean after use.
- Check and tighten the loose nuts and bolts.
- Replace worn out discs and tines; tighten the loose ones.
- Lubricate moving parts.
- Apply old engine oil for long storage.

(d) Rotary tiller

This implement works on the principles of high speed of revolving flail blades which cut the soil together with trash and break up the soil clods. It is driven by the power take off shaft of a tractor. It is commonly used in preparing paddy rice fields. It is also referred to as *rotavator* or *rotary cultivator* .

Uses

- Breaks up large soil clods into smaller ones.
- Achieves two operations in one pass, that is, cuts the furrow slices and harrows them.
- Mixes trash and the soil.

Adjustments on rotavator

- Higher forward speed of the tractor gives the seedbed a fine tilth.
- Depth of work is controlled by depth wheel.

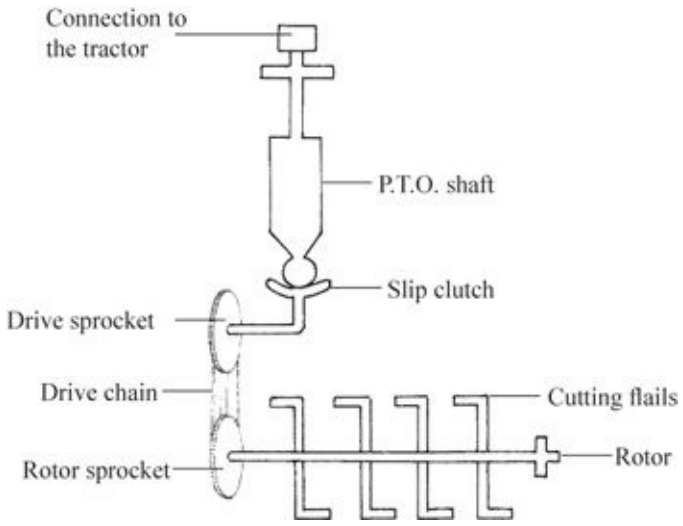


Fig.12.13: Parts of a rotavator .

(e) Mowers

These are mainly used for cutting grass. However, they can be adapted for harvesting cereal crops such as wheat.

There are two common types of mowers namely:

(i) Reciprocating mowers.

(ii) Rotary mowers (Gyro mowers).

(i) Reciprocating mower

It has finger-like extensions on a cutter bar that is held horizontally during mowing. The cutter bar could be 1.5 m to 2 m. The mower gets power through the P.T.O. of the tractor. The cutting blades move to and fro through the fingers on the cutter bar. The reciprocating movement of the knives effect the cutting of vegetation.

Parts of reciprocating mower

- *Swath stick:* Keeps the cut crop or grass falling orderly.
- *Swath board:* Removes the cut crop or grass.
- *Shoe:* Has a runner to absorb the weight and wear.
- *Cutter bar:* Guides the fingers of the mower.
- *Wear plate:* Counteracts downward force and holds the knives in place.

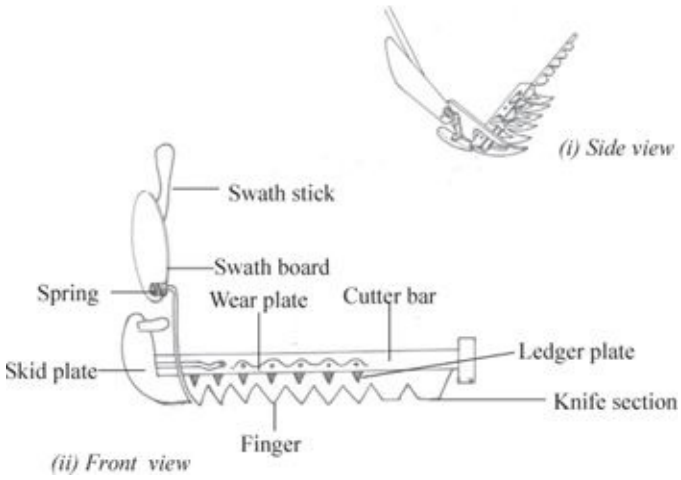


Fig. 12.14: Parts of a reciprocating mower .

(ii) Rotary mower (Gyro mower)

The cutting edge consists of two metal blades fitted opposite each other on a horizontal disc.

The horizontal disc rotates at a high speed and enables the blades to carry out the cutting. The disc is driven by the power take off shaft of the tractor. This makes it much easier for the operator since the flying objects are restricted from reaching the operator by a shield casing which surrounds the rotating blades. Some rotary mowers are motorised while others could be tractor mounted. It cuts uniformly even where the ground surface is not even.

Adjustment on mowers

Hydraulic lever system is used to raise or lower the blades or cutting knives.

Maintenance of mowers

- Tighten loose nuts and bolts.
- Keep cutting blades sharp.
- Lubricate moving parts.
- Check the tension of vee-belts and adjust them accordingly.
- The cutter bar assembly should be overhauled at the end of the season.
- Coat with old engine oil for long storage. Store properly in a shed when not in use.
- Repair broken parts.

(f) Planters and seeders

These are implements which are used for planting. They open up the furrow, place the seeds in the furrows and cover them.

There are two main types of planters and seeders:

(i) Seed drills — These do not space seeds within the row but drop them continuously. They are used for planting tiny seeds for example wheat and pasture grass.

(ii) Precision planters — These space the seeds according to the preset rate that is, measurement space from one seed to another and from one row to another. Planters also apply fertilizers alongside the placing of the seeds and covering them with soil. Planters are used for planting of large-sized seeds such as maize and beans. The seeds are metered through a perforated belt.

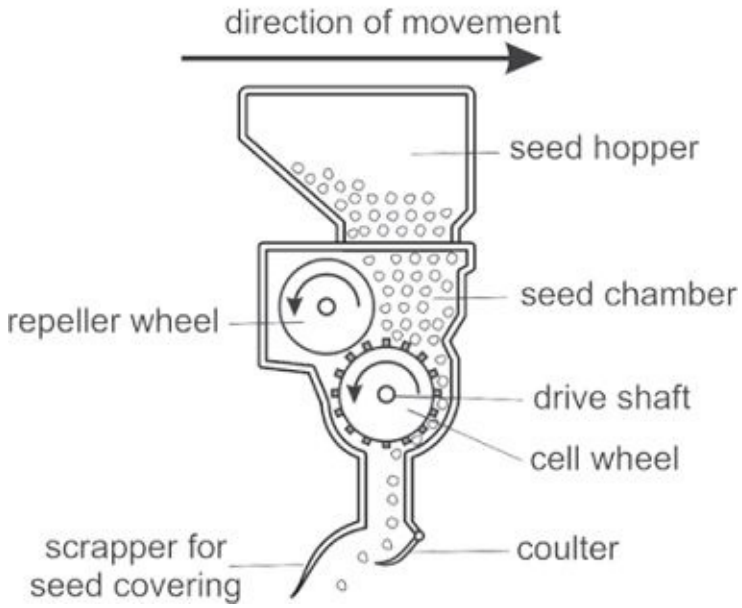


Fig. 12.15: Precision planter

Maintenance of planters

- Lubricate moving parts.
- Remove all seeds from the seed hopper after sowing.
- Remove any stuck seeds in the seed slots.
- Fit the desired belt.
- Dismantle the unit after use.

(g) Cultivators/weeders

These are implements used in tilling the soil after the emergence of the crop. The common types are:

(i) Shovel type.

(ii) Disc cultivator.

(iii) Rotary cultivator.

(iv) Sprine tine cultivator

The shovel and disc cultivators are trailed implements, while the rotary cultivator is mounted and driven by the PTO shaft.

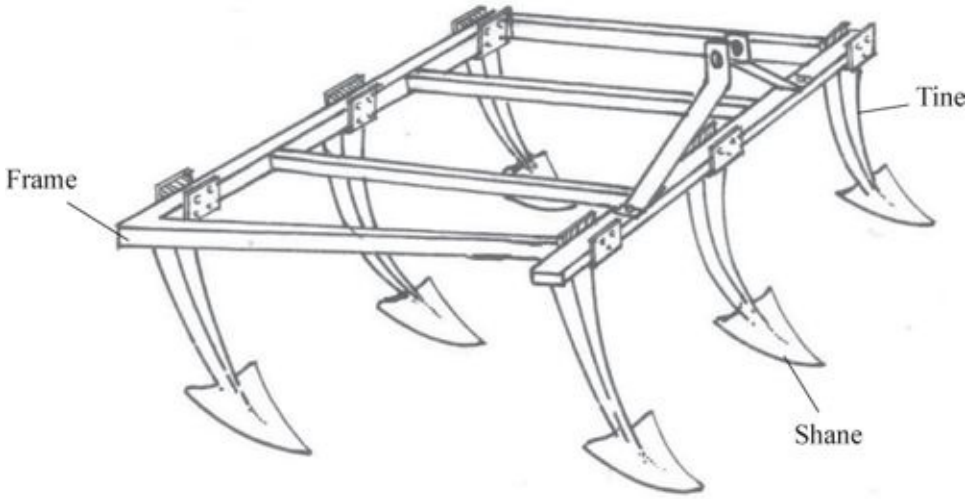


Fig. 12.16: Shovel type of cultivator .

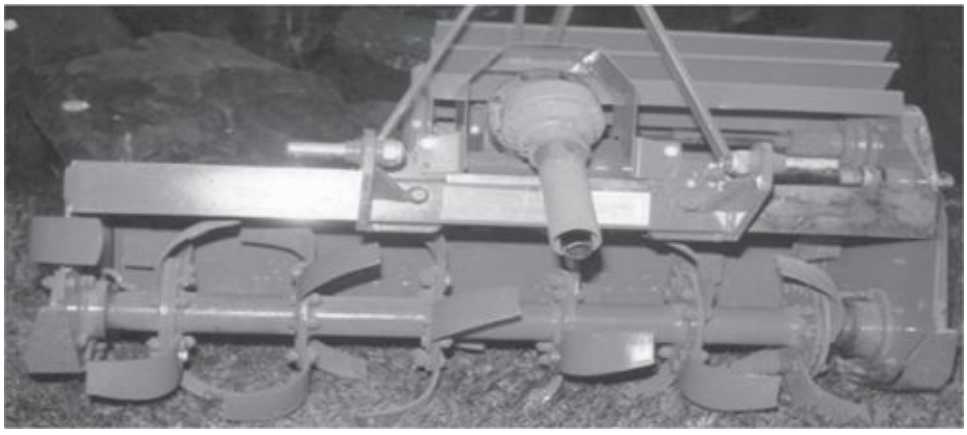


Fig. 12.17: Rotary cultivator .

Adjustment

- Set the cultivators at appropriate width between crop rows that is, maize and beans.

• Set the cultivator to the desired depth of cultivation.
• Set the points to throw soil in the desired direction.

Maintenance

• Lubricate moving parts.
• Sharpen the cultivator points if blunt.
• Replace worn out points.
• Apply oil for long storage.
• Store properly.

(h) Sprayers

These are driven by the P.T.O shaft. They are used to spray water soluble chemicals in crop fields. Sprayers achieve uniform spraying.

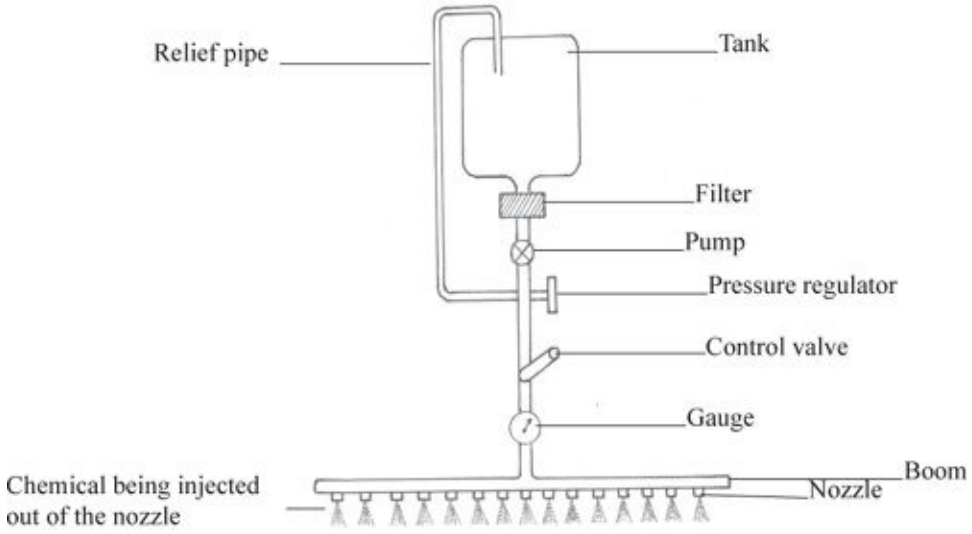


Fig. 12.18: Parts of a Boom sprayer .

Maintenance

• At the end of the day's work, empty the tank and wash the sprayer thoroughly.
• Lubricate moving parts.
• Replace filters and nozzles when necessary.
• At the end of the season, remove the nozzles and store separately.
• The sprayers should be kept under cover when not in use.

(i) Harvesting machines

There are several machines used for harvesting various crops. Crops such as wheat, maize and root crops can be harvested using particular farm harvesting machines.

(i) Combine harvester

This has four main functions:

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

Some combine harvesters are self-propelled while others get power from an external source (P.T.O driven). Combine harvesters are used in the harvesting of several crops such as cereals (maize, wheat, barley).

It is made up of the following main components:

- *Cutter bar:* This has a set of knives and is set at a specific height to cut the grain heads.
- *Pick-up reel:* Directs the crop into the cutter bar for cutting.
- *Elevator:* Channels the cut heads into the threshing drum.
- *Threshing drum:* Shells maize grains from the cobs or removes husks from wheat grains.
- *Straw walker:* Separates the grains from the straw.
- *Fan:* This is used for winnowing the crop.
- *Grain tank:* Holds the grains temporarily.

(ii) Maize shellers

These are stationary machines used to remove grains from maize cobs. They consist of rotating serrated discs which scrape the grains from the cobs. Maize shellers could be hand operated or belt mechanized, that is driven from an electric motor or engine. The large motor driven maize shellers are fitted with fans for cleaning and a screen for separating the grains from the husks and cobs. A large maize sheller may shell up to 1, 500 kg per hour.

(iii) Potato lifters

These are used in harvesting root crops for example Irish potatoes and sweet potatoes. They lift the tubers from the soil and help in collecting them.

(iv) Forage harvesters

These are tractor mounted implemented operated by the power take off shaft. They harvest forage crops such as maize, sorghum and napier grass. It cuts the crop into small pieces by use of the rotor which has two to four flails. The flails cut the crop as the tractor moves. The cut crop is directed into a container by a chute and flap.

Maintenance of harvesting machines

• Tighten loose nuts & bolts.
• Lubricate moving parts.
• Store under a shed.
• Remove foreign materials stuck in the machines at the end of the day's work.
• Repair or replace worn out or broken parts.
• Cutting edges should be sharpened regularly.
• Apply oil for long storage.

2. Animal drawn implements

Animal drawn implements are generally categorised into:

• The walking type, which have no provision for the operator to sit on.
• The riding type, which has provisions for sitting on and is more balanced due to the presence of wheels.
Animal drawn implements include ox ploughs, ox harrows, seed drills and carts.

(a) Ox-plough

This is a mould board plough, only that it has one mouldboard, hence it is lighter than a tractor drawn mouldboard. An ox-plough is drawn by draught animals such as oxen and donkeys. It is used for ploughing, weeding and opening furrow in which seeds are placed during planting. It may also be used for harvesting crops such as groundnuts.

Parts of ox-plough and their functions

• ***Main beam***

- Provides attachment to all other parts of the plough.
- Adds weight to the plough for better penetration into the soil.

- ***Handles***

Allow the operator to steer the implement in the proper direction during ploughing.

- ***Mouldboard***

Inverts the cut soil (slice).

- ***Share***

Cuts the furrow slice horizontally.

- ***Landside***

Stabilizes the plough.

- ***Land wheel***

Regulates the depth of ploughing. Assists the operator in controlling the ploughing direction.

- ***Draft rod***

It is fitted with a chain that connects the plough to the yoke chain.

- ***Hake***

It is used for holding parts of the plough which have been adjusted in position.

- ***Depth rod***

Used for adjusting the width and depth of ploughing. If the rod is moved to the left, it leads to a widened slice size and if it is moved to the right, it narrows the slice size. If it is raised, deep ploughing is achieved and vice-versa.

- ***Frog***

Provides attachment for the mouldboard, share and landsides.

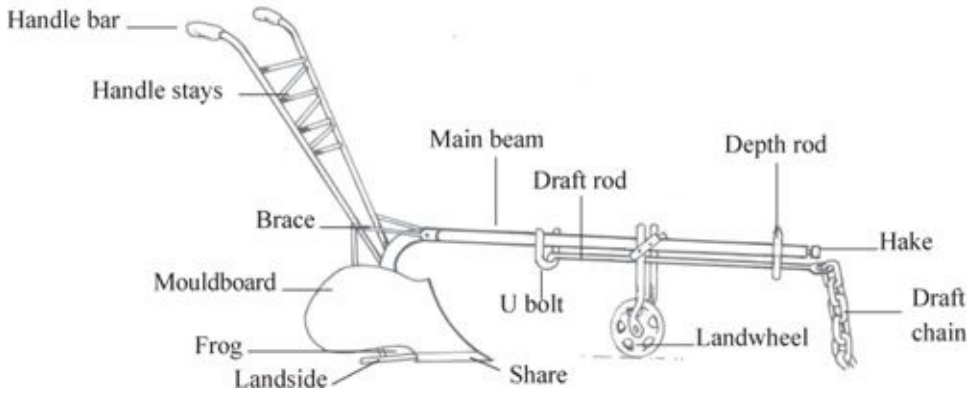


Fig. 12.19: Parts of an ox-plough .

Maintenance practices

- Lubricate land wheel hub.
- Clean after use.
- Straighten bent share.
- Replace worn out parts e.g. hooks, draw bar assembly, share.
- Check and tighten loose nuts and bolts before the day's work.
- Oil the shiny metallic parts, such as mouldboard, during long storage.
- Paint the handles, beam and braces to prevent rusting.
- Store properly in equipment shed.

(b) Carts

An ox-cart has two rear wheels and is mostly pulled by two animals. The animals are harnessed by the use of a yoke.

Carts are used in transportation of farm produce from the farm to the store or to the market, and to transport manure, water, and other farm inputs.

Maintenance

- Grease moving parts of the wheel.
- Ensure the yoke is properly padded for proper harnessing of the animals.
- Replace broken parts.
- Check tyre pressure before each day's work and adjust accordingly.

(c) Ridger

This is an implement used to make ridges. It has two mouldboards fixed opposite

each other on the main beam. When pulled, the mouldboards make two soil heaps and a single furrow. A return pass completes the ridge making. A set of two or three ridge making mouldboards are assembled together.

Advantages of animal drawn implements

- The initial cost of purchasing such implements is low.
- Require less skill to operate.
- Can be used in almost all types of topography.
- Has low maintenance costs.

Disadvantages

- They provide shallow cultivation.
- Animals are slower than tractors.
- They are less durable compared to tractor drawn implements.
- They rely on animals which can either fall sick or be in poor physical state.

Fig. 12.20: Ridger

Practical Activity 12.2

- Visit a nearby mechanised farm and identify the various types of machinery used and how they are maintained.

Safety measures when using farm machinery

It is important to observe safety measures when using farm machinery to minimise accidents.

The following are some of the safety measures which should be observed by farmers.

(i) Before using machines, read operation manual, danger precautions and safety regulations.

(ii) Make sure that all machines have start and stop buttons within easy and convenient reach of an operator.

(iii) Ensure that all cutting tools and blades clean, sharp and in good working order so that they will cut freely.

(iv) Do not wear loose clothing such as neckties when operating the machines.

(v) Do not leave machines running unattended.

(vi) Keep hands safe during cutting procedures.

(vii) Do not try to free a stalled blade before turning the power off.

(viii) Make sure that all machines are properly mounted on the ground before use.

(ix) Wear protective clothing such as overalls, breathing masks, gloves and boots during spraying.

(x) Always wear safety goggles in metal work.

(xi) Wear hearing protection devices when working with a noisy machine.

(xii) Never smoke or eat anything while working with machines.

(xiii) Never spray against the wind direction to avoid drift to unintended areas.

(xiv) Wash your body thoroughly and change clothes after spraying.

(xv) Dispose off any chemical left-overs and empty containers properly.

(xvi) Clean spraying equipment thoroughly.

(xvii) Do not wash spraying equipment in any water source.

(xviii) Store chemicals in a safe place, out of reach of children and away from food stores.

(xix) Keep proper records of all chemical applications.

(xx) Do not use machines when you are tired.

(xxi) Never carry a tool by the cord or hose.

(xxii) Turn the power off and unplug the power cord when the machine is not in use.

(xxiii) Clamp down and secure all work pieces when drilling or milling.

(xxiv) Do not overload wheelbarrows, ox-carts and tractor trailers.

(xxv) Ensure tractor systems are well maintained.

(xxvi) Do not touch the engine when it is hot and running.

(xxvii) Do not use compressed air to remove sawdust and turnings from machines.

Factors to consider when mechanizing a farm

There are several factors a farmer should consider when mechanising a farm, some of which include the following:

- **Availability of capital**

  Machines are expensive to install and maintain.

- **Size of land**

  Mechanization is economical in large tracts of land.
  Where there are small land holdings it is uneconomical to mechanize the farm operations.

- **Availability of technical skills**

  It requires skilled and qualified personnel to operate most machines. This technical know-how may not be easily available, making it very expensive to hire the skilled personnel.

- **Environmental assessment**

  Mechanization often leads to environmental pollution, deforestation and erosion especially where large tracts of land are cleared and the crop grown does not provide ample ground cover.

- **Employment opportunities**

  Unskilled farm labour will often lose their employment and these are the majority in developing countries like Malawi. However it should be noted that mechanization creates more job opportunities in the long run as it

increases production and more will be employed in marketing channels of the produced products.

- **Topography**
  Mechanization is easier done in fairly gentle slopes to relatively flat land. In steep slopes it becomes impossible to operate.

- **Accessibility**
  The land should be accessible for ease of movement of machines.

- **Support services**
  Spare parts should be easily available for maintenance of the machines. Machine experts should be easily available to help farmers in utilizing the machines.

- **Improved infrastructure and social amenities**
  Farm mechanization requires well distributed road networks, widespread electrification and water systems. This also includes well structured marketing channels for various products.

Revision Exercise 12

1. What is farm mechanization?
2. State some three animal drawn implements.
3. Give the advantages of farm mechanization.
4. Outline the maintenance of tractor drawn mouldboard plough.
5. State four field conditions under which disc plough is preferred to a mouldboard plough.
6. Besides the disc plough, state three other tractor drawn implements used in primary cultivation.
7. State five maintenance practices carried out on trailers.
8. Give the parts of tractor operated sprayer.
9. State three implements which are used in harvesting of crops.
10. Give the functions of the following parts of an ox-plough:
    (a) Mouldboard.
    (b) Land wheel.
    (c) Frog.

(d) Share.

11. State four daily maintenance practices carried out on an ox-plough.
12. Name tractor-drawn implements that are mounted on a three point hitch.

Agricultural Experimentation

Topic 7

Agricultural Experimentation

Unit 13: Report Writing

Unit 13 Report Writing

Specific objectives

By the end of this unit, you should be able to:

(a) Outline the format of a report.

(b) Write a report.

Introduction

Agricultural experimentation is a fundamental tool of research in agriculture. It is used to identify solutions to existing problems. Research is a systematic inquiry into a particular subject for example poverty eradication, land policy and many others so as to discover new facts. A good experiment should be simple and very precise. Once an experiment is over, a report should be done outlining the findings of the experiment and the most appropriate recommendations.

Basic terms used in report writing

• Data

This is a set of measurements of a particular variable in an experiment for example number of aphids per groundnuts plant.

• Variable

This is any measurable characteristic of an experiment for example plant height, days to flowering, yield, panicle size among others.

• Variability

This is a characteristic of a biological material for example number of flowers in a plant and size of the tubers in a tuber crop.

• Population

This is a set of counts of a single variable.

• Sample

This is a set of measurements obtained from part of the specified population.

Format of a report

Agricultural reports are investigative in nature hence the need of experimentation. Below is a simple format of presenting an agricultural report.

(a) Title

This should be clearly written in capital bold letters. It shows the title of the report at a glance and sometimes the names of the authors.

(b) Introduction

This gives a brief description of the issue under investigation.

(c) Aims and objectives

This stipulates what the experiment tries to find out. They must be specific and clearly put down.

(d) Materials and methods of investigation used

This stipulates any materials used in carrying out the agricultural experiment and the mode of investigation that is to be used.

(e) Design of the experiment

This briefly describes the set up of the tools and instruments used in the experimentation.

(f) Data collection

This shows the means and methods of collecting data depending on the type of data to be collected.

(g) Data analysis

This is interpretation of the data collected. The interpretation may be in form of tables, charts and graphs. This may involve calculation of means, mode, median, standard deviation and others.

(h) Results

Where the findings are discussed and interpreted.

(i) Conclusion

This shows the findings and the result in a summary form.

(j) Recommendations

This is usually a word of advice to the target client, either the individual farmers or the government. It should be based on the conclusion.

In report writing, always:

- Use simple and clear language.
- Avoid personalising the report, do not use "I" "we" but use reported speech such as "the maize was planted at a spacing of 90 cm × 30 cm" planting was done at the onset of the rains".
- Avoid using a lot of words, be brief.
- Be precise.
- Do not use vague language.
- Use paragraphs to indicate the main idea(s).
- Ensure any graphic aid used such as graphs, tables and photographs have a title and are clearly numbered.

A sample report

Title

A study of the effects of planting dates on the yield of five maize hybrids.

Introduction

Maize (*Zea mays*) is an important crop grown all over the world. In most countries in Africa, increase in population has outstripped the available food supply. Environmental changes related to different sowing dates have a modifying effect on the yield of maize. Each maize variety has an optimum sowing date. Any deviation from the optimum sowing date leads to yield loss. Early planting or late planting can lead to low yields since unfavourable conditions can occur during the growing period. This study was aimed at evaluating the effects of planting date on grain yield.

Materials and method

- Two independent experiments were carried out in a randomised complete block design with three replicas.
- Five hybrids of maize represented by A, B, C, D and E were tested using two sowing dates with a difference of two weeks.
- The hybrids were planted in two row plots at a spacing of 90 cm x 30 cm. Two seeds were planted per hole but later thinned to one seedling.
- Fertiliser application was based on soil testing results. Weeds, pests and disease control were carried out similarly in all the plots.
- Data was recorded and the yield was calculated for the entire plot.

Data analysis

All the data collected was recorded and analysed as shown in the following table.

Effects of early planting and late planting dates on yield on different maize hybrids

Maize hybrid	Total yield in tons/ha		
	Early planting	Late planting	% change
A	13.7	16.0	16.78
B	16.3	16.5	1.22
C	14.8	16.2	9.46
D	14.2	13.4	-5.63
E	14.6	14.3	-2.05

Results and analysis

The study showed that hybrid B (16.5 ton/ha) had the highest yield in early planting and hybrid A (13.7 ton/ha) had the lowest yield. Hybrid B (16.5 ton/ha) had the highest yield in late planting and hybrid D (13.4 ton/ha) had the lowest.

The study also showed hybrid A was the most affected by delayed planting (16.78%) and hybrid D (-5.63%) was the most affected by early planting.

Discussion

Planting date had significant effects on hybrid maize yield. Hybrid B (16.3 ton/ha) was the best for early planting and hybrid B (16.5 ton/ha) was still the best for late planting.

Both planting dates and the hybrid had significant effects on grain yield.

Conclusion

It has clearly been shown that planting date had significant effects on maize hybrid yield. Hybrids A, B and C should be planted early and hybrid D and E should be planted late with respect to the rain.

Practical Activity 13.1

- Invite a resource person and let him/her take the students through how to write technical agricultural reports.

Revision Exercise 13

1 . Outline the stepwise procedure of writing an agricultural report.

Topic 8

Challenges in Agricultural Development

Unit 14 Effects of Land Degradation on the Economy

Specific objectives

By the end of this unit, you should be able to:

(a) Explain the effects of land degradation on the economy.

(b) Develop an appreciation for the effects of land degradation on the economy.

Introduction

Agricultural production largely depends on the ability of the soil to produce high crop yields. The top most horizon of the soil is usually rich in plant nutrients. This potential of the soil to produce high crop and livestock yields has been going down. One of the major factors for this is land degradation.

Land degradation is the gradual transformation of a previously productive and valuable land into a non- productive and useless land.

Land degradation in Malawi has in the recent past escalated to alarming levels. This has been due to:-

- Rapid population increase leading to scarcity of arable land.
- Poor farming practices.
- Poverty, making people to exploit forest products for a living.
- Greed, where people unlawfully practice deforestation to enrich themselves fast.

The above, together with other factors has resulted to:

(a) Overstocking: This is the keeping a large number of livestock beyond the carrying capacity of the land. This leads to overgrazing and denudation of the soil hence soil erosion.

(b) Deforestation: This is the indiscriminate cutting of trees and failure to plant others, exposing the soil to agents of erosion.

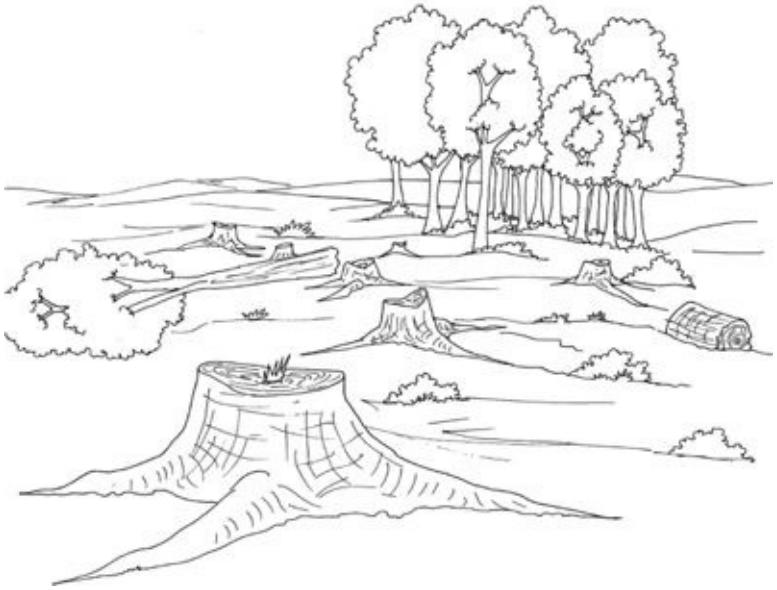


Fig. 14.1: Deforestation

(c) Cultivation along river banks due to inadequate arable land exposes the soil to river bank erosion.

(d) Encroachment of water catchment areas leading to scarcity of water.

Land degradation and the economy

Land degradation impacts negatively on the economy in the following ways:

(a) The land is left agriculturally unproductive due to the loss of top fertile horizon of the soil. This translates to low production of crops and livestock.

(b) Decline in agricultural production leads to low income levels of the country's population who are mainly in the agriculture sector. The general drop in agricultural production due to soil degradation will translate to:

- Loss of foreign exchange since there is less agricultural produce to export.
- The country will use a lot of its little foreign exchange to import livestock and crop produce to cover for the deficit.

(c) A low income society remains poor and has low standards of living. They may not afford quality education for their children, proper housing and proper feeding.

(d) A society with low standards of living may not access quality food leading to poor health. An unhealthy society cannot be fully engaged in economic activities especially in agriculture. A healthy nation is a wealthy nation, the

reverse is also true.

(e) Soil degradation leads to siltation of water bodies such as rivers and dams. For example, the sedimentation of Lake Malombe due to gullying of Malombe catchment. This reduces the capacity of such water bodies to hold adequate water. Desilting such water bodies is expensive and labour demanding. It also affects generation of hydropower..

(f) Soil degradation also results to water pollution, where agrochemicals such as pesticides, fungicides and inorganic fertilizers are washed down into water bodies. This water may not be fit for consumption by human beings and livestock. Such polluted water requires to undergo treatment which is equally expensive. Pollution also leads to death of aquatic organisms such as fish, this affects the livelihoods of people living near water bodies as they rely mainly on fish, for example along the shores of Lake Malawi.

(g) Damage of infrastructure, such as roads, railway and water systems. This may cut off an area from the rest interfering with transport and communication. Inputs and farm produce cannot be taken into or out of such an area. The government incurs a lot of expenses in repair of such infrastructure.

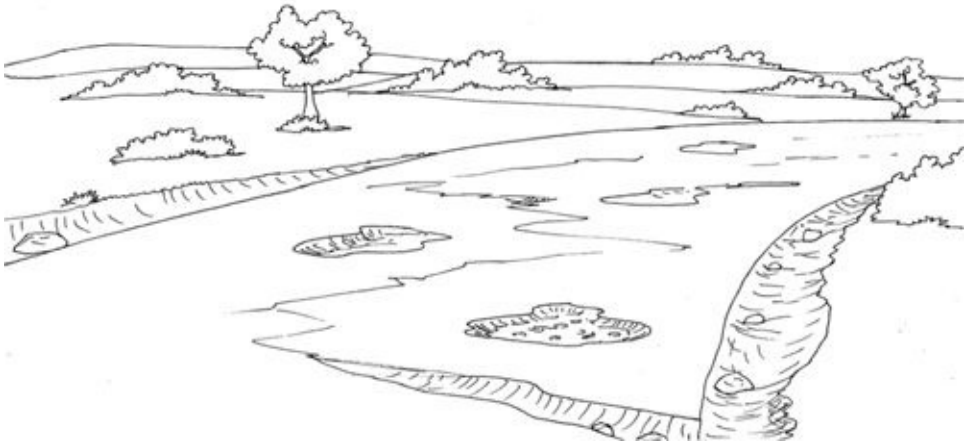


Fig. 14.2: Damaged road

Practical Activity 14.1

1. Conduct a panel discussion on the implications of land degradation on the economy.
2. Debate the extent to which land land degradation has contributed to slow

economic development in Malawi.

Revision Exercise 14

1 . Outline four effects of land degradation to the economy of Malawi.

2 . State three factors that have led to escalated land degradation in Malawi.

Unit 15 Food Security IV

Specific objectives

By the end of this unit, you should be able to:

(a) Describe food security through use of drought resistant varieties.

(b) Explain food security using scientific and technological innovations (green revolution).

Introduction

Food security can be defined as “adequate production and access to the staple food.” In Malawi, the main staple food is maize which is grown by over 90% of the farm households. Alternative food crops include rice, millet, cassava, sorghum, bananas among others.

Most of the farm households rely on erratic rain fed agriculture and hence some are even unable to meet their subsistence requirements.

Use of drought resistant crops varieties to achieve food security

These are crop varieties that have the ability to withstand long spells of drought. They are early maturing crops and farmers in arid and semi arid like Chikhwawa areas should be encouraged to grow such crops. Such crops ensure adequate food supply to the Malawi households both in the dry season and when waiting for the main staple food to mature. Some drought resistant crops like cassava, yams and sweet potatoes can remain in the soil for a long time to be harvested in time of food scarcity. They can also be harvested, processed locally and stored for future use. Other drought resistant crops include sorghum and millet. Planting of drought resistant crops can greatly alleviate the impacts of drought.

Fig. 15.1: Cassava

Use of scientific and technological innovations to achieve food security

Several scientific and technological innovations can be used to reduce food insecurity in Malawi. Some of these are discussed below.

(i) Increased land production potential; this can be achieved through expanded use of modern inputs such as:

- Pesticides to reduce crop loss through pest damage.
- Fertilizers to increase the level of soil nutrients and hence high crop yields.
- Regular vaccination of livestock to keep at bay endemic diseases. This reduces the cost of livestock production.
- Manufacture of high quality commercial livestock feeds. This ensures livestock produce highly and they reach market weight early.

It can also be achieved through:

(ii) Intensive research to come up with superior crop varieties and livestock breeds. Such will be high yielding, disease and pest/parasite resistant and also early maturing.

(iii) Use of irrigation: Use of irrigation both at small holder and large scale production rather than rely on rain-fed farming. This ensures high crop yield and hence continuous supply of food. Irrigation systems like flood, basin, furrow, overhead and drip could be adopted.

(iv) Improved technology on food storage and preservation. Most agricultural produce are highly perishable and serious losses are registered due to poor storage structures. Better methods of crop storage and preservation should be put in place. This involves use of silos and cyprus bins, for grains of cereals and legumes, and cold storage facilities for highly perishable

produce like vegetables and meat products.

(v) Processing technology: This is where highly perishable produce can undergo processing to come up with products that have a long keep quality. This is most appropriate for fruits such as mangoes and livestock products like milk and meat products.

(vi) Farm mechanization: Use of farm machinery to carry out various operations on the farm. Machines help to carry out activities faster and hence on time. Timely operations such as land preparation, planting, pest and disease control practices and weeding translates to increased performance of the crop. Mechanization also enables farming on large scale since machines have high output per unit time compared to human labour.

Practical Activity 15.1

- Visit an agricultural research station and find out research activities aimed at solving food insecutiy.

Revision Exercise 15

1. Name four drought resistant crops that may be grown in dry parts of Malawi.
2. Give three benefits of growing drought resistant crops.
3. List four modern inputs whose use can increase food security in Malawi
4. Outline other scientific and technological innovations that can be used to improve food security in Malawi.

Unit 16 Population and Land Policy in Agriculture

Specific objectives

By the end of this unit, you should be able to:

(a) Explain the meaning of the term ‘land tenure’.

(b) Describe land tenure systems in Malawi.

Introduction

Land is the most important factor in agricultural production without which no meaningful agriculture can be practiced. Malawi, being an agricultural country, even makes land more valuable. More than 84% Malawians depend on agriculture for their livelihood. The size of the land, in one way or the other determines the yield, thus every one would wish to have as large piece of land as possible.

What is land tenure?

Land tenure refers to the condition under which one owns land or has rights to the use of a particular piece of land. Such conditions influence how one utilizes and takes care of the land.

Land tenure systems in Malawi

In Malawi, there are three types of land tenure systems namely:

(a) Customary land tenure system.

(b) Public land tenure system.

(c) Private land tenure system.

(a) Customary land tenure system

This is the type of land ownership where the land belongs to the community. It is characterised by the following:

- The land is governed under the customary laws.
- The custodian of the land is the community head, usually the chief.
- Each member of the community is given land by the chief.
- Land issued to a particular member depends on his needs.
- Once allocated to a particular member of the community, the land is passed on through inheritance to the allocatees descendants.
- The land is allocated without any payment.
- The community owns the land.

Advantages of customary land tenure system

- No incidence of landlessness because each member is allocated a piece of land free of charge.
- Being a member of the community confers the allocatee some degree of security.
- Member has freedom on the use of the land.
- Land disputes are settled by the chief.

Disadvantages of customary land tenure system

- The farmers cannot use the land as collateral to secure credit.
- There is no incentive to improve the land since he has no absolute power over its utilisation.
- When one dies, the land is subdivided to his children leading to small uneconomical units.
- An individual can be allocated small pieces of land a distance from each other leading to land fragmentation.
- It may lead to overgrazing and improper land use as each member is not restricted on the number of animals to keep.
- Does not allow buying or selling of land among the members, hence hardworking members who would wish to progress are limited in doing so.
- Plots are usually small, hence no benefits of economies of scale.
- Mechanisation is impossible due to small size of land.

(b) Public land tenure system

This is where the land is held in trust by traditional authorities or the government. The land could be under:

- Government forests.
- Game and national reserves.
- Conservation areas such as water catchment and marshy areas.
- Government roads and institutions.

Advantages of public land tenure system

- Allows conservation of natural resources for example, trees and wildlife.
- Can be used to settle the landless people.
- Allows room for development of public infrastucture.
- Government can earn income through leasing such land.

Disadvantages of public land tenure system

- Land can remain unutilised for a long time.
- There is high likelihood of encroachment on the land by landless people.

(c) Private land tenure system

This can also be referred to as individual land tenure. It can be held under:

(i) Freehold.

(ii) Leasehold.

(i) Freehold

The land is absolutely owned by an individual or a group of people. The land is registered and has a title deed. No fee is charged for this type of tenure.

Advantages of freehold

- The farmer can acquire agricultural credit by using the land as collateral/security.
- Soil and water conservation measures are practiced because the individual would want to benefit from the land for a long period of time.
- Returns from the investment are normally high. This is because the farmer has incentives to conserve soil and water hence soil productivity is maintained.
- Farmer can easily carry out sound farm planning since he/she is the sole decision maker.

• Land disputes are minimal.
• The owner can liquidate the land to raise money.

Disadvantages of freehold

• It may lead to land lying idle.
• It leads to unequal land distribution.
• Land may not be put into maximum use in case the owner does not have enough capital and or skills to operate the land.
• May lead to sale of the land in case it was used as a security against credit and the farmer is unable to pay.

(ii) Leasehold

This is where the land is allocated to an individual or company for a particular use for a specified period of time. The leasee pays a certain amount of money as rent. The lease period is usually 99 years.

Lease period varies according to type of land and the purpose for that land. Currently they are put into three categories.

(i) 21 year leases for agricultural land.

(ii) 33-99 year leases for property and infrastructure development.

(iii) Over 99 year leases for developers who may have to sub-leased to tenants on 99 year leases.

Advantages of leasehold

• Enable those who have no land to access it for agricultural use.
• It ensures maximum utilisation of arable land as land is less likely to lie idle.
• Enables the government to earn income in form of rent.
• Usually the land leased is usually large hence benefits from economies of scale.

Disadvantage of leasehold

• Unequal distribution of land.

Practical Activity 16.1

1. Visit a nearby farm and enquire about the type of land tenure under which they operate.
2. Organise debate on the advantages and disadvantages of tenure systems.

Land distribution policy in Malawi

The issue of inequitable land distribution in Malawi, has been a pertinent problem. Some of the important aspects of land distribution policy are listed below:

1. Each member of the community has access to a plot of land for subsistence farming. This is done through the community chief.

2. Ensuring hardworking farmers who would wish to practice farming at large scale commercial level have access to land through leasehold system of land tenure.

3. Government buying idle land from estate and small holder sectors and distributing it to able and entrepreneural farmers.

4. Strengthening of land rights of women and orphans.

Equitable land distribution

Equitable land distribution does not mean equal land sharing. It however, means the distribution of enough land to the farmer according to his or her needs and requirements.

Importance of equitable land distribution

- Ensure efficient utilisation of land hence food security. This is done through strengthening the customary land reform and redistributing idle land to farmers willing to do large scale farming.
- Helps to remove the perennial problem of land fragmentation and land subdivision.
- Equitable land use will ensure increased food production hence food security in the country.

Revision Exercise 16

1 . Define the term ‘land tenure’.
2 . Name the types of land tenure common in Malawi.
3 . State the problems associated with customary land tenure.

4 . What are the advantages of private land tenure?
5 . State two importances of equitable land distribution.

Unit 17 Population Policy and Agricultural Development Policy

Specific objective

- By the end of this unit, you should be able to explain how population policy and agricultural policy assist in national development.

Introduction

Malawi's 2020 vision states "By the year 2020, Malawi as a God fearing nation will be secure, democratically mature, environmentally sustainable, self reliant, with equal opportunities for and active participation by all, having social services, vibrant cultural and religious values and being technically driven middle income country (SDNP – Sustainable Development Network Programme)".

One of the key areas that will influence the direction the country intends to take is that of agriculture and food security. Rapid population growth can be a bottleneck towards achieving the country's vision 2020.

Malawi's population policy

Malawi's population policy aims at improving the standard of living and quality of life of all the Malawians. It also aims at keeping the national population at manageable level, by reducing the population growth rate. Thus, the policy can be achieved through:

- Enlightening the population on the benefits of having small and manageable families.
- Ensuring education is accessible to all both the boy and the girl child so that each can be able to make sound decision as far as the size of the family is concerned.

• Educating the citizens on various methods of family planning and making them easily available to all the people.

A manageable population will:

- Help reduce pressure on available land given that land size does not increase but the population increases geometrically.
- Reduce the national demand on tree related fuels for example firewood and charcoal. This will help to save the existing forests from degradation.
- Ensure the water catchments are safe from encroachment by those who become landless.
- Ensure the farms are of economically viable size by preventing land subdivision.

All the above will enhance national development.

Malawi's agricultural development policy

Malawi's agricultural development policy on the other hand aims at improving food security and produce for the export market so as to earn foreign exchange.

Food security in a country is defined in terms of adequate production and access to the staple food. In Malawi, the staple food is maize which is grown by about 90% of the farm households. Many of these farmers:

(a) Operate small uneconomical units of land.

(b) Rely on rain fed agriculture where the rain is erratic.

(c) Do not use modern technology.

(d) Have poor market information and hence prone to exploitation by middlemen.

Given that food security is a prerequisite for sustained economic growth and poverty reduction, the agricultural policy aims at reversing the above scenario and hence stimulates national development.

Role of population policy and agricultural development policy in national development

Both policies will guide the government in:

(a) Planning in the following areas:

- Infrastructure development for example road network and railway network.
- Health facilites such as hospitals and dispensaries.

- Education facilities such as schools and colleges.
- Marketing channels both at national and international level.
- Agricultural research based on the expected development.

(b) Guiding the distribution of agricultural services.

Agricultural services such as production credit, extension services, processing and others, will only be provided where they are required, in regard to agricultural activites taking place.

Revision Exercise 17

1. State two aims of Malawi's population policy.
2. State two aims of Malawi's agricultural policy.
3. How do the population and agricultural policies promote national development?

Unit 18 Agro-based Industries

Specific objectives

By the end of this unit, you should be able to:

(a) Explain the meaning of agro-based industries in Malawi.

(b) Identify agro-based industries in malawi.

(c) Assess the role of agro-based industries in supporting the growing popualtion.

Introduction

An industry is a group of firms dealing with the same product. Malawi, being an agricultural country, is bound to have a variety of agro-based industries. Majority of agro-based industries are mainly found in urban areas due to the good infrastructure.

Meaning of "Agro-based industry"

Agro-based industries are firms dealing with processing agricultural products or producing agricultural inputs, tools and machinery.

Agro-based industries in Malawi

Basically, there are two types of agro-based industries namely:

(a) Processor agro-based industries.

(b) Manufacturer agro-based industries.

Processor agro-based industries deal with converting agricultural produce, then raw materials, into finished products such as:

(a) Grain and milling industries: They grind grains such as maize, wheat, millet and sorghum into flour. A good example is the Grain and Milling Company Limited.

(b) Tobacco processing industries: These process tobacco leaves into cigarettes. A good example is the British American Tobacco (BAT) Malawi Limited.

(c) Malawi dairy industries: These process milk into various products for example whole milk, skim milk, milk powder, butter, ghee, cheese and yoghurt. Examples of dairy industries are Lilongwe Dairy and Mpoto Dairy Farmers Association.

(d) Lever brothers: Process oil-rich seeds such as groundnuts, cotton seeds and sunflower seeds into various products such as peanut butter and cooking oil.

(e) Cold storage: Deal with highly perishable agricultural products such as beef and beef products. An example is Lilongwe Cold Storage. These offer cold storage for fruits and vegetables.

(f) Textile industries: These uses cotton as the raw material to produce textile products. An example is David Whitehead and Sons Limited.

Practical Activity 18.1

- Visit a nearby agro-based industry and find out the activites carried out there.

Role of agro-based industries in supporting the growing population

Any firm has a duo-role namely:

- A producer.
- A consumer.

As a producer, the industries play the following roles:

1. Provide the farmers with farm inputs such as fertilizers, seeds, agro-chemicals, tools, equipment and farm machinery. This translates to improved agricultural production.
2. Provide farmers with finished products such as clothes, beverages, processed food products and those that the farmers do not produce.

As a consumer agro-based industries play the following important roles:

1. Buy raw materials from the farmers thus creating market. This way the

farmers earn income to improve their living standards and expand their farming activities.

2. They process the raw materials into finished products some of which are used locally and others exported to earn foreign exchange.
3. Create employment to the people of Malawi.

The industries upon selling these products, earn income. The income can be used to buy more raw materials from the farmers to expand the industry.

Revision Exercise 18

1. Define agro-based industry.
2. Name the two types of agro-based industries.
3. Name four agro-based industries in Malawi.
4. State four roles of agro-based industries in supporting the growing population.

Unit 19 Gender and Agricultural Development

Specific objective

By the end of this unit, you should be able to relate the involvement of women in decision making in agricultural development.

Introduction

In a rural home set up in Malawi, women are generally involved in agricultural activities both in small holder sub-sector and estate sub-sector. They are mainly the ones who are involved in most manual work for example, digging, planting and harvesting. However, major decisions affecting agriculture in many of these rural homes is left to men, who also happens to be the heads of such families. Women are not allowed to make decisions like culling unproductive livestock or selling of the major farm produce.

In most cases, men are employed in urban areas leaving women to take care of the farm. However, even in this scenario, the men (husbands) must be consulted before women make any decision. What to produce, how much to produce, how to produce and when to sell, are very important guiding questions towards success in agricultural production. They require careful analysis and consideration before any decision is made. They also require one who is practically and directly involved in agricultural production, in this case women. This should not be the situation in Malawi because it significantly affects agricultural production negatively.

Involvement of women in decision making

There is need to involve women in decision making in agricultural production. One of the main reason why women are rarely involved in decision making is because they are considered to be of low status. For improved agricultural production, there is need to empower women socially, politically and

economically. This can be achieved through:

1. Availing equal opportunities in education to both the boy child and the girl child. This gives the girl child (women) confidence that “what men can do, women can do” This will strengthen their position in decision making.
2. Enlightening the population on the immense contribution women can make in agricultural development and view them as partners and not as subordinates.
3. Developing documentaries for the print and electronic media, on successful women farmers, to serve as role models to would-be upcoming women farmers.
4. Review land and property ownership. This will ensure women own land and property. In addition, education will empower women economically and will enable them to make careful and informed decisions based on their practical knowledge in farming.
5. Providing more opportunities for women in the political arena so that more women can be involved in decision making especially to matters pertaining gender parity.

Practical Activity 19.1

- Interview local farmers on involvement of women in decision making in agriculture.

Revision Exercise 19

1. Identify the impact of gender bias in agricultural development.
2. Identify gender bias in decision making in agricultural production.
3. Suggest ways of eliminating gender bias in agricultural production.

Unit 20 HIV and AIDS and Agricultural Development

Specific objective

By the end of this unit, you should be able to explain how HIV and AIDS impacts agricultural development in Malawi.

Introduction

Health is one of the factors that influence labor productivity. A healthy and a strong worker can be able to work for a relatively longer period of time than a sick one. HIV and AIDS is one of the most serious health concerns in the world today. Immune-Deficiency Virus (HIV) is the virus that causes Acquired Immune Deficiency Syndrome (AIDS). HIV weakens the body defense mechanism making it more susceptible to other diseases. The first cases of AIDS in Malawi were reported as early as 1985.

How HIV and AIDS impacts on agricultural development in Malawi

HIV and AIDS impacts negatively to agricultural development in the following ways:

1. Reducing the labour force

HIV and AIDS gradually weakens the farm workers reducing their ability to do meaningful work. When people with AIDS die due to opportunistic diseases such as tuberculosis, malaria and typhoid, this reduces the number of people available for work. Reduction of available farm labour makes it very expensive thus affecting profitability of agricultural production.

2. Wastage of valuable time

Sickly HIV and AIDS infected individuals usually stay at home practically doing nothing. When their condition deteriorates, they call for intensive care

from the other members of the family. This is double tragedy since the two members of the family will not be involved in agricultural activities. This may lead to total neglect of the farm resulting to low agricultural production.

3. Low living standards

HIV and AIDS infected individuals and their relatives may suffer from hopelessness due to uncertainty in their future life. They lack motivation to invest in agriculture thus reduction in agricultural productivity.

4. Wastage of valuable resources

This is both at family level and at government level, hence everybody is affected by HIV and AIDS even if not infected. Family members use a lot of resources for the proper upkeep of the individuals with HIV and AIDS. These people require special diet and treatment. All these may lead to depletion of the family's farm capital leaving the family hopeless. This hampers agricultural development. The government on the other hand uses a lot of resources in research for curing and managing HIV and AIDS and also for purchasing of expensive drugs to keep the disease at bay.

Estimated number of adults and children living with HIV

Year	2001	2007
Adults 15+ and children	850 000	930 000
Low estimate	790 000	860 000
High estimate	910 000	1 000 000
Children (0–14 yrs)	65 000	91 000
Low estimate	57 000	80 000
High estimate	74 000	100 000
Adults 15+	780 000	840 000
Low estimate	730 000	780 000
High estimate	840 000	900 000
Adults (15–49)%	13.3	11.9
Low estimate	12.4	11.0
High estimate	14.3	12.9
Women 15+	440 000	490 000
Low estimate	410 000	450 000
High estimate	480 000	530 000

Source: UNAIDS/WHO 2008 .

Practical Activity 20.1

Discuss with your friend how HIV and AIDS affects farming.

Revision Exercise 20

1. Outline various ways by which HIV and AIDS affects agricultural production.
2. Explain how HIV and AIDS affects agricultural development in Malawi.

Sample Examination Paper

Paper I: Subject Number: M012/I

Time allowed: 2 hours

Section A (60 marks)

Answer all the ten questions in this section .

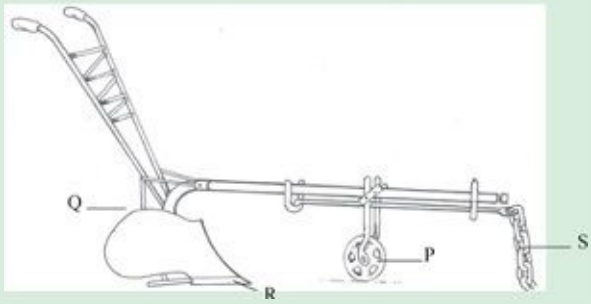
1. (a) Name any two exotic breeds of dairy cattle reared in Malawi. (2 marks)

   (b) Give four features that make Malawi zebu breeds more popular. (4 marks)

2. (a) Give two fungal diseases of maize. (2 marks)

   (b) List four general symptoms of viral diseases in crop production. (4 marks)

3. Below is a diagram of an animal drawn implement. Study it carefully and answer the questions that follow.



   (a) Name the parts labelled P,Q,R and S. (4 marks)

   P _____

   Q _____

   R _____

S _____

(b) State one function of the part libelled P and S. (2 marks)

P _____

S _____

4. (a) Briefly describe the following sources of power in the farm.

(i) Fossil fuel. (1 mark)

(ii) Biomass. (1 mark)

(iii) Electrical. (1 mark)

(b) Give five differences between diesel and petrol engines. (5 marks)

5. A farmer has 4 plots P1, P2, P3 and P4 each of the plots has an agronomic problem as indicated below.

Plot 1	Plot 2	Plot 3	Plot 4
Infested with bacterial wilt	Deficient in nitrogen	Infested with striga (witch weed)	Prone to soil erosion

(a) A farmer intends to grow maize, tomatoes, groundnuts and rhodes grass. Plan a crop rotation programme for the first year. (4 marks)

(b) Justify your crop rotation programme in (a) above. (4 marks)

6. (a) Name two types of concentrates fed to broilers. (2 marks)

(b) State four features of a good broiler house. (2 marks)

7. (a) Give four ways of improving farm labour. (4 marks)

(b) Other than labour, state two factors of production. (2 marks)

8. (a) State four reasons for controling weeds in pasture. (4 marks)

(b) Give three methods of pasture establishment. (2 marks)

9. State five disadvantages of customary land tenure system. (5 marks)

10. State four precautions observed in the use of silage. (3 marks)

Section B (40 marks)

Answer all the four questions in this section. Your answers should be in an essay form .

11. Explain five ways in which biological weathering brings about soil formation. (10 marks)

12. Outline the benefits a farmer would get by being a member of a co-operative. (10 marks)

13. Describe the life cycle of a tapeworm. (10 marks)

14. Explain five market functions. (10 marks)

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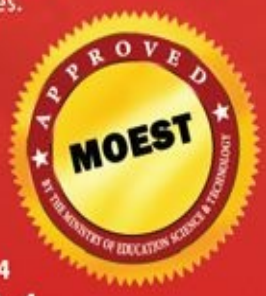

The authors have served in the education sector in various capacities where they have contributed immensely in the field of Agriculture. They also have a wide experience in teaching and curriculum development.

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