CHAPTER 1: SOIL DEGRADATION

Introduction

Soil is one of the most important natural resources in agriculture. This is where all crop production activities are done. Farmers are doing whatever they can to harvest bumper yields. These activities range from the use of hybrid crop varieties to the modification of soil properties. Some of these activities are impacting negatively on the general properties of the soil that you looked at in your form three agriculture.

Objectives

By the end of this chapter you will be able to:

- *Explain the meaning of the term 'soil degradation'.*
- *Describe forms of soil degradation.*
- *Explain the causes of soil degradation.*
- *Describe the effects of soil degradation on crop production.*
- *Explain the relationship between rapid population growth and soil degradation.*
- *Describe how to control soil degradation.*

Meaning of the term 'soil degradation'

Soil degradation refers to the massive loss in quality and value of soil on a particular piece of land. It can also be defined as the drastic decrease in the ability of the soil to support crop growth.

Forms of soil degradation

Activity 1.1

- *Get into groups of five.*
- *Brainstorm some factors that you may look at to conclude that the soil on a particular field has been degraded.*
- *Record your findings and share them with other students in your class.*

Your answers can be summarized into three different forms in which soil degradation exists. These are:

a. physical soil degradation.
b. biological degradation.
c. chemical degradation.

Physical soil degradation is a form of soil degradation that is directly connected with the destruction of soil structure and texture. Physical soil degradation results in:

- poor aeration
- reduced infiltration
- compacted soils
- increased run-off causing soil erosion
- difficulty in workability of the soil as it may be too hard or waterlogged

Biological soil degradation is a form of soil degradation that occurs when the organic components of the soil have been modified or destroyed. An example of this organic component is humus. This organic component of

the soil may be changed by animals, micro-organisms and people. These are the biological agents of soil degradation. Biological soil degradation causes:

- poor aeration.
- poor water holding capacity of the soil.
- increased run-off and reduced infiltration.
- reduced soil fertility.

Chemical soil degradation is a type of soil degradation which occurs when chemical properties of the soil are modified to toxic levels. These chemical properties of soil are soil pH and Cation Exchange Capacity (CEC). These properties are changed due to heavy use of chemical fertilizers such as sulphate of ammonia and poor farming practices such as continuous cropping. The modification of the chemical properties of soil affects the availability of some essential plant nutrients and the action of important soil micro-organisms.

You will see from the above discussions that human beings are central in causing soil degradation of all forms.

Causes of soil degradation

The causes of soil degradation can be grouped into **direct** and **indirect**.

The direct causes of soil degradation include:

- damaging soil structure by cultivating the soil when it is either too wet or dry.
- improper use of heavy machinery thereby damaging soil structure.
- exhausting the soil by practicing continuous cropping.
- cultivating on steep slopes and along river banks.

The indirect causes of soil degradation include:

- rapid population growth which puts pressure on the limited land resources for settlement and cultivation. This forces people to settle and farm in marginal lands such as catchment areas and steep slopes.
- deforestation as a result of careless (wanton) felling (cutting) down of trees due to high demand for timber products and land for settlement.
- overgrazing as a result of overstocking. A lot of animals are allowed to graze on a small piece of land as much of the land is used for cultivation and settlement.

Effects of soil degradation on crop production

Hopefully the above explanations have given you a hint on the effects of soil degradation. Now do activity 1.2 below.

Activity 1.2

- *Get into the groups that you formed in activity 1.1.*
- *Discuss some of the effects of soil degradation on crop production.*
- *Record them in your exercise books and report to the class.*

Your discussions may have yielded the following effects:

- Loss of fertile top soil resulting in reduced crop yields.
- Accumulation of excess salts due to poor soil drainage which makes the soil not suitable to some crops.

Fig. 1.1 Degraded land due to soil erosion

- Difficulty in using machines during farm activities for instance in places with gullies. This makes farmers produce less than they would produce using machines.
- Siltation of irrigation dams or wells affecting irrigation of crops.
- Pollution of water sources resulting in poor quality irrigation water.
- Destruction of crops due to frequent floods as a result of siltation of water sources.

Methods of controlling soil degradation

Activity 1.3

- *Get into your groups*
- *Brainstorm some of the methods of controlling soil degradation*
- *Record them in your exercise books and report to your class for discussions.*

Your discussions in activity 1.3 might have reminded you of the two groups of soil conservation measures that you looked at in your form one agriculture. These are the biological and physical soil conservation measures. Do you still remember these?

Physical conservation measures assist in reducing the speed of runoff, therefore, allowing more time for the water to infiltrate into the soil. They include:

- constructing contour bunds
- constructing box or tie ridges
- constructing check dams that help to store water that could just have been flowing

Biological soil conservation measures are aimed at providing ground cover as such reducing the impact of rain drops. They also reduce the

speed of run off and bind the soil together. Some of the biological measures include:

- mulching.
- controlling bush fires.
- practicing rotational grazing.
- Afforestation.
- planting crops that cover the soil such as groundnuts and sweet potatoes.
- practicing agroforestry.
- practicing strip cropping.

Activity 1.4

Visit some farmers in your area and find out if soil degradation has affected their crop production activities. If yes, find out what they are doing about it. Compare their responses with what you have learnt.

Chapter summary

- *Soil degradation refers to the decrease or loss in value and quality of soil.*
- *The three forms of soil degradation are physical, biological and chemical.*
- *Soil degradation causes loss in soil fertility, soil erosion and reduction in crop yields.*

- *Soil degradation can be controlled through physical and biological soil conservation measures.*
- *The best way of controlling soil degradation is by practicing good methods of farming.*

End of chapter exercise

1. In your own words, define the term ‘soil degradation’.
2. Describe the three forms of soil degradation.
3. List the causes of soil degradation.
4. Mention the effects of soil degradation.
5. Explain how soil degradation can be controlled.

CHAPTER 2: AGRICULTURE AND CLIMATE CHANGE

Introduction

At your junior secondary school level, you looked at agriculture and climate change. Hopefully, you looked at the causes of climate change and its effects on agricultural production. Review your junior certificate agriculture to refresh your memory. In this chapter you will look at ways of mitigating the effects of climate change.

Objectives

By the end of this chapter, you will be able to:

- *Explain the meaning of the term 'climate change'.*
- *Mention causes of climate change.*
- *Mention effects of climate change on agriculture.*
- *List ways of dealing with climate change.*
- *Describe ways of dealing with climate change in agriculture.*
- *Explain how each measure can deal with climate change.*

Meaning of the term 'climate change'

Climate change refers to any abnormal deviation from the normal pattern of climatic factors such as rainfall and temperature. For instance, if an area has been known to be very cold and it has just changed to be hot, then the climate of the area is said to have changed. Remember climate is the average atmospheric condition of an area over a long time. Do not confuse it with weather. What is weather?

Cause of climate change

The major cause of climate change is the accumulation of greenhouse gases (GHGs). These gases include carbon dioxide, methane, hydro

fluorocarbons (HFCs) and nitrous oxide. These gases intercept and reflect back the light that is reflected by the earth. This makes the earth warmer than normal. The GHGs are released into the atmosphere due to human activities.

Activity 2.1

- *Get into your groups.*
- *Brainstorm human activities that can emit GHGs into the atmosphere*
- *Record the answers in your exercise books and report them to the entire class for comments.*

Compare your answers to activity 2.1 with the following:

- deforestation
- heavy use of pesticides in agriculture
- bush fires
- over dependency on firewood for cooking and heating
- heavy use of chemical fertilizers in agriculture
- careless disposal of farm and industrial wastes such as chemicals
- burning of papers and tyres

Effects of climate change on agriculture

The following are some of the effects of climate change:

- Increase in temperatures resulting in drying up of rivers and wells making irrigation water scarce. Drying up of water sources also makes drinking water for livestock hard to find.
- Erratic rains affect crops that rely on a lot of rainfall.

- Rains start late and end early making planning by the farmer difficult.
- There are frequent cases of floods and droughts.
- High temperatures provide a suitable condition for the multiplication of pests and diseases.
- Pasture becomes scarce due to poor rains received that results.
- High temperatures result in drying up of fish ponds.

Apart from the above effects, what are other effects of climate change you are experiencing in your area?

Ways of mitigating the effects of climate change in agriculture

Activity 2.2

- *Be in pairs.*
- *Discus the activities that can be done to deal with the effects of climate change.*
- *Record your answers and prepare to present your answers to the class for comments.*

Some of the ways of mitigating the effects of climate change in agriculture are:

- Crop diversification.
- Conservation agriculture.
- Rain water harvesting.
- Re-afforestation.

1. **Crop diversification**

Crop diversification is the growing of more than one crop by the farmer within the same growing season. This is done to reduce the risks of crop failure. The crop failures may be as a result of drought, floods, pests and disease out-breaks that are rampant due to climate change. Some of the cropping systems that achieve diversification include:

a. Mixed cropping or intercropping

This is a cropping system that involves the growing of more than one crop on the same piece of land. The inclusion of leguminous crops improves soil fertility that in turn improves yields. The growing of more than two crops also reduces the total failure by the farmer as one of them may do better during harsh conditions.

b. Strip cropping

Strip cropping involves the growing of different crops in alternating field blocks. The strips can be planted with crops of different pest problems and weather tolerance as a safeguard against crop failure. Strips also reduce soil erosion.

c. Relay cropping

Relay cropping is the growing of seasonal crops before the first crop is harvested. For instance a farmer may grow beans as soon as the maize crop starts drying ready for harvesting. A farmer harvests two crops in one growing season and soil fertility is improved when legumes are included. All this is aimed at reducing the risk of total failure.

d. Agroforestry

Agroforestry is the practice of raising trees together with crops, and or livestock on the same piece of land. It may be practiced for the following reasons:

- Trees assist in absorbing carbon dioxide which is one of the GHGs. This is why trees are known as carbon sinks.
- Trees mixed with crops help to provide wind break and reduce soil erosion
- Agroforestry tree species such as *Faidhebiaalbida* (Msangu) help to improve soil fertility and therefore increasing crop yields.

2. Conservation agriculture

Conservation agriculture is a farming practice that combines the following three basic principles:

a. minimum soil disturbance.
b. permanent soil cover.
c. crop rotation.

The aims of practicing conservation agriculture are to:

- produce high crop yields while reducing production costs.
- maintain soil fertility.
- conserve water.

a. Minimum soil disturbance practices

To achieve the above benefits of conservation agriculture takes time since it is a slow process. The following are some of the technologies that are aimed at ensuring minimum soil disturbances:

- permanent planting pits/basins
- herbicide application
- contour planting

Permanent planting pits/basins are small pits constructed in the ground used for planting different types of crops. They should be 30 cm wide, 30 cm long and 20 cm deep. They are best suited to areas that receive less

than 1, 000mm of rainfall annually. Correctly constructed planting pits may be used for planting different crops for many years.

During harvesting of crops planted in permanent pits, remove the crop by cutting plants at the base. Stems and leaves should be left on the surface of the soil. The roots should not be uprooted but should be left to decompose within the pit.

Herbicide application: Correct application of herbicides helps to remove weeds without disturbing the soil. The demand for labour to do weeding is reduced as such minimizing production costs. Correct use of herbicides reduces the population of weeds in the field over time. This reduces the amount of herbicides to be applied.

Contour planting involves planting crops in ridges made across the slopes. To achieve minimal soil disturbance the ridges can be used for several years. They can be properly reconstructed after harvesting crops such as groundnuts or tubers.

Note that maximum benefits of minimum tillage can best be realized if integrated with soil cover and crop rotation. Other interventions such as application of compost manure and planting of agro-forestry trees should be promoted.

b. Permanent soil cover

Permanent soil cover involves the covering of the soil using the following:

- living or dead plant material applied as mulch.
- green manure, cover and forage crops.
- crop residues.
- fallow vegetation.

Advantages of permanent soil cover

Activity 2.3

- *Get into your groups*
- *Research some of the advantages of permanent soil cover*
- *Record your answers and prepare to report to the whole*

Compare your answers with the following points:

- Reduces run-off.
- Increases water infiltration.
- Reduces the rate of evaporation, thus conserving soil moisture.
- Prevents soil erosion caused by running water and wind.
- Controls the multiplication of weeds.
- The incorporation of plants into the soil assists in carbon sequestration.
- Protects the soil from rain drops impact.
- Prevents the overheating of soil surfaces.

Challenges of soil covering

There are a number of challenges associated with soil covering. Some of them include:

- uncontrolled bush fires during the dry season.
- need to feed crop residues to livestock during the dry season.
- mulch may retard humification especially where water may limit microbial activity for the decomposition of the mulch.

- research has shown that crop residues lower crop yields on the sites where soil fertility was low and no additional fertilizers were applied.

c. Crop rotation

Crop rotation increases crop yields, adds organic matter to the soil and improves soil fertility. Crops differ in the quantity and quality of the residues they produce and this has an effect on soil management. For example, leguminous crops and oil crops produce fewer residues that decompose faster, have a lower carbon/nitrogen ratio and are easier to manage during direct sowing than grain crops. Consider rotating crops with different root systems and nutrient fixing ability.

3. Rain water harvesting

Rain water harvesting is the process of collecting and storing water from direct rainfall, runoff and underground water sources. It is aimed at reducing loss of water through evaporation, runoff and deep percolation. Harvested water can be used for:

- irrigating crops during dry spells.
- recharging ground water sources.
- domestic use during the dry season.
- fire fighting.

Some of the rain water storage systems are:

- earth dams.
- rock catchments.
- sand dams.
- farm ponds.
- water storage tanks.

4. Re-afforestation

Re-afforestation is the act of planting trees in areas where the trees were cut. The following are some of the reasons why trees are important:

- they use carbon dioxide and give us oxygen.
- they help in preventing and controlling soil erosion.
- they help to conserve water.

Fig. 2.1: Maintaining forest cover reduces GHGs emission

Chapter summary

- *Climate change refers to a big change in the pattern of climatic factors.*
- *Climate change is caused by the accumulation of greenhouse gases (GHGs) such as carbon dioxide and methane.*

- *Human activities such as deforestation, bush fires and heavy use of pesticides assist in causing climate change.*
- *Climate change causes erratic rains, floods, drought and unbearably high temperatures.*
- *The effects of climate change can be mitigated through crop diversification, conservation agriculture, rain water harvesting and re-afforestation.*

End of chapter exercise

1. What is climate change?
2. Mention any **two** examples of greenhouse gases that cause climate change.
3. List five human activities that assist in climate change.
4. Explain effects of climate change on agriculture.
5. Describe how the effects of climate change can be mitigated.

CHAPTER 3: WATER SUPPLY AND LAND DRAINAGE

Introduction

Water is very important in agriculture. It is essential for livestock and it forms a large part of all plant tissues. Water dissolves nutrients in the soil for plant use. Water is also used to transport produce from the farm to the market, generation of electricity and operation of water wheels for grinding grain. Although water assists us in many ways, it also causes very big problems. It causes water logging which affects plant growth. It is a main agent of soil erosion. Water also causes floods. In this chapter you will look at the sources of water, the water cycle, land drainage.

Objectives

By the end of this chapter, you will be able to:

- *Describe the water cycle*
- *Mention sources of water.*
- *State the meaning of the term 'land drainage'.*
- *Explain the importance of land drainage.*
- *Describe methods of land drainage.*

The water cycle

The water cycle is also known as the hydrological cycle and it comprises several processes (figure 3.1).

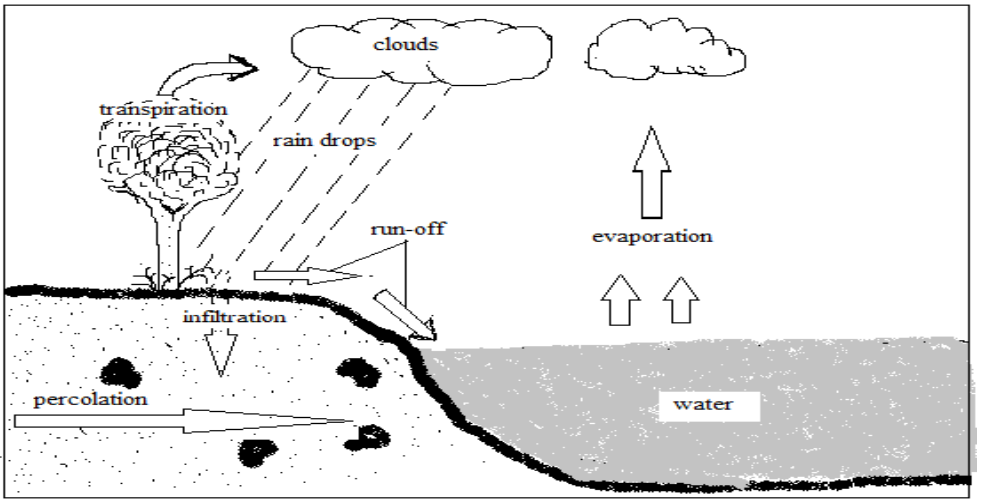

Fig. 3.1 The water cycle

Definitions of some terms in the water cycle

Evaporation: Evaporation is the loss of water from the surface of water bodies and soil into the atmosphere as water vapour.

Transpiration: Transpiration is the loss of water from the plants especially leaves into the atmosphere.

Evapotranspiration refers to the combined loss of water from water and soil surfaces (evaporation) and plants (transpiration).

Run-off is water that runs on the surface of the earth when rain falls.

Infiltrationrefers to the entry of water into the soil from the surface of the earth.

Percolation is the movement of water in the soil.

Activity 3.1

- *Be in pairs.*
- *Think of the ways of disturbing the water cycle and its effects on agriculture.*
- *Record your answers clearly and prepare to present them to the entire class for comments.*

The major source of water in Malawi is rainfall. This makes the agricultural sector to depend much on rainfall. Due to the unreliability of rainfall as a result of climate change, farmers have resorted to irrigation. In your form 2 agriculture you looked at the systems of irrigation.

Sources of water in Malawi

The major source of water in Malawi is rainfall. This makes the agricultural sector depend much on rainfall. Due to the unreliability of rainfall as a result of climate change, farmers have resorted to irrigation. Irrigation water is obtained from shallow or deep wells, rivers, dams and lakes. In your form 2 Agriculture you looked at the systems of irrigation. The major systems of irrigation that you looked at include:

Furrow irrigationwhich involves taking water from rivers or dams in furrows to the field.

Flood irrigationwhich involves flooding the entire piece of land with a lot of water

Basin irrigation is a special type of flood irrigation system that involves taking water into a basin

Drip irrigation: In drip irrigation, water is taken to each planting station using small pipes that have holes. The holes are found in places where the planting stations are.

Problems connected with irrigation and how to solve them
The following are some of the problems connected with irrigation:

Water logging: Waterlogging happens due to the application of too much water to the crops. In waterlogged soils, crops do not grow well since roots fail to respire due to inadequate oxygen as there is poor aeration. Nutrients are also washed down through leaching and the decomposition of organic matter is heavily affected due to the reduced microbial activity. This problem can be checked by applying only an adequate amount of water to crops.

Salt accumulation: Salt accumulation refers to the accumulation of salts in the soil through irrigation using water that contains dissolved salts. When the irrigation water evaporates it leaves the salts behind. The salts that may be left behind include calcium, magnesium, potassium, chloride and potassium sulphates. These salts make the soil become saline. Saline soils are not suitable for most types of crops. The accumulation of sodium salts makes the soil become alkaline. Excessive sodium can lead to the breakdown of soil structure and the formation of a hard layer below the soil surface which makes irrigation very difficult.
Soils can be saved from becoming saline by irrigating using salt-free water. If it does happen, the problem can be solved by periodic leaching of the salts by allowing water to soak through the root zone and out into the drains which carry it out. Alkaline soils can be improved by applying gypsum or sulphur which can be expensive to the smallholder farmer.

Soil erosion: Soil erosion happens due to the application of too much water to the crops resulting in run-off which carries the soil away. Soil erosion may also take place when the irrigation unit was not constructed properly e.g. furrows made too steep or is not rehabilitated frequently. Soil erosion can be prevented by closely monitoring and maintaining irrigation structures such as furrows.

Land drainage

Land drainage is the process of removing excess water from the soil. It is done when the water table is very high or there is excess surface water which is failing to infiltrate. Land drainage helps to control soil moisture in the root zone. It does this through the prevention of any waterlogging condition which has a lot of effects on crop production as explained above.

Methods of land drainage

There are two methods of land drainage which are:

- surface drainage
- sub-surface drainage

Surface drainage involves removing excess water running on the surface of the earth. The water may originate from rainfall or irrigation. The surface water is carried by using open or surface ditches and deposited into water bodies such as rivers and dams. The water moves in the ditches using the force of gravity to these water bodies. These ditches are similar to those constructed along the road side of most tarmac roads. Figure 3.2 shows an example of an open ditch.

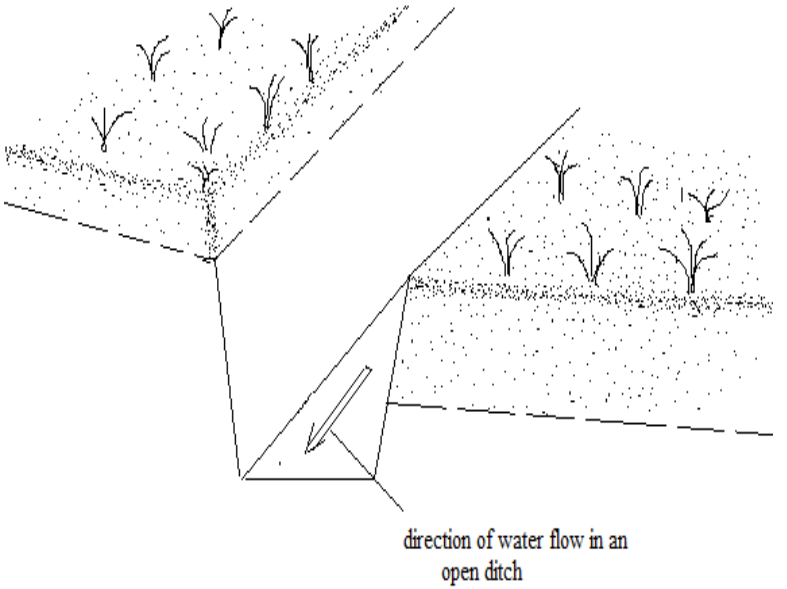

Fig. 3.2 Open ditch

Open ditches need to be maintained frequently to protect them from siltation and weeds that may block them. The construction of open ditches is not expensive. However, it has a problem of interfering with farm mechanization.

Activity 3.2

You are going to have an educational visit to one of the nearest irrigation schemes. Prepare to see how water is drained to avoid waterlogging conditions. Remember to find out from the authorities how the irrigation unit is managed to avoid other effects associated with irrigation apart from waterlogging e.g. salt accumulation.

Sub-surface drainage is used to get rid of excess underground water which is directed either to a canal or river. Sub-surface drainages are constructed to reduce the levels of underground water to avoid waterlogging conditions. They are constructed by using pipes or ceramic tiles. This method of land drainage is relatively expensive to construct and maintain as opposed to surface drainage. They have an advantage of not hampering with farm machines such as tractors. Figure 3.3 is an example of a sub-surface drainage.

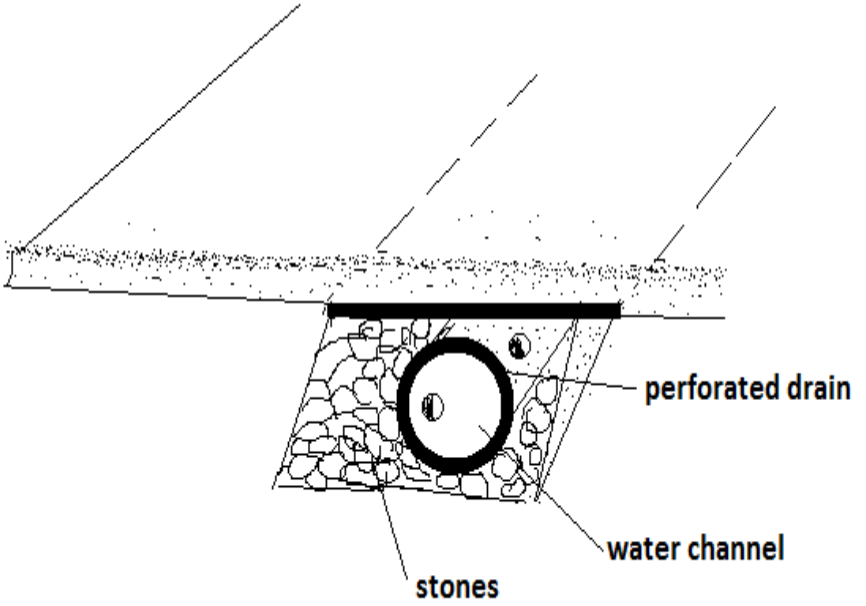

Fig. 3.3 Sub-surface drain

Importance of land drainage

- Soil aeration is improved, and this is essential for root growth and uptake of nutrients and water by plants.
- It enhances soil microbial activities, which are essential for the decomposition of plants.
- It warms up the soil and this increases the rate of seed germination, shoot and root development.

Chapter summary

- *The main source of water for domestic use and agriculture is rainfall.*
- *Irrigation is used to reduce the risk of hunger.*
- *Irrigation needs to be done with care to avoid soil erosion, salt accumulation, and waterlogging.*
- *Waterlogged conditions can be prevented by constructing land drainage systems.*
- *The two methods of land drainage are open or surface drainage and sub-surface drainage.*

End of chapter exercise

1. Mention the **four** systems of irrigation.
2. Mention any **five** reasons for irrigation.
3. Describe any **three** problems connected with irrigation.
4. Using well labelled diagrams, describe the two methods of land drainage.

CHAPTER 4: FARM POWER AND MECHANISATION

Introduction

Smallholder farmers always try to get bumper yields in each growing season. However, they fail to achieve this because of several factors. One of the factors is the failure by farmers to complete crop management activities such as land preparation, irrigation, weed control, harvesting and post-harvest processing on time. Most farmers use hand held tools such as hoes to cultivate their crops. Human beings have a limitation of having low strength and a low power output. Therefore, productivity can be improved with farm mechanisation.

Objectives

By the end of this chapter, you will be able to:

- *Explain the meaning of the term 'farm power' and 'farm mechanisation'.*
- *Describe sources of farm power.*
- *Describe the advantages of different sources of farm power.*
- *Describe the limitations of different sources of farm power.*
- *State ways of improving output from different sources of farm power.*
- *List types of farm machinery.*
- *Explain factors to consider when mechanizing a farm.*
- *State the advantages of farm mechanisation.*
- *State the limitations of farm mechanisation.*
- *Describe the maintenance of various farm machinery.*
- *Describe safety measures when using farm machinery.*

Sources of power

Power refers to the ability to do work. The amount of work to be done depends on the amount of energy applied. The words power and energy are mostly used interchangeably. There are different sources of energy that are of paramount importance in agriculture. Some of them include:

Wind power

Wind power is a type of energy that is used for driving windmills that are used to generate electricity that can be used to pump water for irrigation and provide heat and light in livestock pens.

Advantages of wind power

1. It is clean as opposed to fossil fuels such as coal.
2. Production cost is relatively cheap.
3. It is sustainable because it is a renewable source of energy.
4. It does not contribute to air, water and ground pollution.

Disadvantages of wind power

1. Wind may not be available all the time and this may affect its availability.
2. The initial installation cost is high as turbines, windmills and generators should be bought to generate electricity.
3. It cannot be stored so as to be used during calm periods.

Solar power

Solar power is energy in form of heat and light that comes from the sun. This energy can be used directly on the farm for drying products such as maize grains. It is also used for the generation of electricity by the use of a battery with solar cells. The electricity developed can now be used for

pumping irrigation water, heating and other uses. Solar energy is also used for photosynthesis in green plants and supplying vitamin D to livestock.

Advantages of solar power

1. It does not cause pollution to the environment.
2. It is easy to be used by small scale farmers.
3. It is a sustainable source of energy.

Disadvantages of solar power

1. The initial installation cost is very high especially on large farms.
2. The generation of power may be affected by clouds, seasons or darkness.
3. Only 30 % of solar energy is converted to electricity by solar panels and this limits supply.

Fuel power

Fuel power is a type of energy that is generated from charcoal, wood, coal, oil and gas. Petrol and diesel are used for running machines. Wood and charcoal are used for producing heat for cooking and heating. The heat can be used for warming young animals, incubating eggs and drying grains. The smoke from the wood can also be used to cure tobacco. Coal is used for heating and running locomotives.

Advantages of fuel power

1. Oils and gases are more efficient to burn, easier to transport and distribute (through pipes and tankers).
2. The energy can be stored and used in times of need.

Disadvantages of fuel power

1. The burning of charcoal, wood, oils and gases can cause air pollution, global warming and acid rain.
2. It can cause destruction of the land through open mining of coal.
3. They are non-renewable natural resources.

Biogas

Biogas is now being made on farms. The biogas produced is known as methane. It is made from organic wastes such as animal droppings. The organic wastes are left to decompose in an environment free from oxygen. This is known as aerobic decomposition. The decomposition takes place in a structure known as the digester. The end product is methane which is a flammable gas.

The gas is then transferred to places such as livestock pens and other places where it is needed through pipes.

Advantages of biogas

i. It is relatively cheap.
ii. It provides a ready place for the disposition of excess manure for the gas production.
iii. The energy can be stored for future use.

Disadvantages of biogas

i. It creates a high demand for manure and this forces farmers to buy inorganic fertilizers which are mostly expensive for smallholder farmers.
ii. Methane gas produced during the use of biogas may cause global warming because it is a green house gas.

Water power (Hydro-electric power)
Water energy is used to generate electricity by driving turbines. The electricity may be used for domestic and industrial purposes.

Advantages of water power

1. It is a sustainable source of power as water is a renewable natural resource.
2. The dams used act as water reservoirs and this reduces the occurrence of floods.
3. It is a clean source of energy.
4. It is relatively efficient.

Disadvantages of water power

1. Construction of dams for the generation of energy may be expensive.
2. The energy cannot be stored for future use.
3. The water levels may fall resulting in insufficient generation and supply of power.

Human power is the energy that is stored in the muscles of the human beings. This type of energy is known as mechanical energy. It is used for cultivation and doing all farm activities. The major advantage of this source of power is that it is relatively cheap and readily available. The major limitation is that it cannot be used on a large scale.

Animal power involves the use of drought animals that are used for pulling implements and ox-carts for transporting things. The source of power can be used on a large piece of land in cases of ploughs and ridgers. The ox-cart is a very cheap source of transport for agricultural inputs and

yields. The major limitation to this source of power is that the drought animals used are expensive. A lot of money is needed to purchase them, making the initial cost high.

Activity 4.1

- *Get into pairs.*
- *Discuss some of the sources of power that are commonly used in your area and why.*
- *Record your answers and prepare to report them to the entire class for comments.*

Farm mechanisation

Farm mechanisation is the process of using machines to carry out farming activities. A machine is any device that makes work easy. For something to be called a machine it does not mean that it should look complex. The most important thing is that the device should make farming activities easy.

Advantages and disadvantages of farm mechanisation

Activity 4.2

- *Get into your groups.*
- *Brainstorm the advantages and disadvantages of farm mechanization.*
- *Record your responses in your exercise books and prepare to present them to the entire class for discussions*

The following may be some of the advantages you have discussed:

1. Mechanisation makes farming activities easier.
2. It allows farmers to have time for other developmental activities other than farming.
3. It leads to improved crop and livestock production.
4. Farm mechanisation enables farm activities to be done faster and on time.

The disadvantages of farm mechanisation include:

1. The use of machines on farms may take over the jobs of many people which results in increased cases of unemployment.
2. Most machines are expensive to buy and operate.
3. A trained work force is needed to operate and maintain the machines. This increases farm expenses.
4. Some machines are limited to flat terrains .
5. Machines are only used when the soil is neither too wet nor too dry to avoid destroying soil structure.
6. Machines cannot be used on some crops. This leads to under utilisation of the machines.

Factors to consider when mechanising a farm

The following are some of the factors that need to be considered when one wants to mechanise a farm:

- **Accessibility of the land**: The site should be able to allow machines such as tractors to reach it for operations
- **Slope or terrain**: Machines are easier to use on flat land than on steep slopes.
- **Size of the farm to be used**: It is economical to buy and use machines on large farms rather than on small pieces of land that are also highly fragmented. However, small scale farmers have a chance of coming together and hiring tractors from the government through the tractor hire scheme.
- **Ease of obtaining capital**: Most machines such as tractors are very expensive and they need a substantial amount of money to buy.
- **Availability of trained work-force:** The farm manager should be sure of getting skilled labour to operate, maintain and repair the machines.
- **Value of the crop:** The crop to be cultivated under mechanisation should be of high value so as to easily recover the expenses associated with mechanisation.
- **Crop demand:** The crop under mechanisation should be on high demand on the market so as to sell it easily at a high cost.
- **Level of infrastructural development:** Farm mechanisation goes together with improved infrastructure such as roads, electricity, market systems and water supply.
- **Availability of spare parts**: The farmer should make sure that the spare parts of the machine are easy to find locally.

- **Availability of fuels and oils:** The farmer should do thorough research on whether fuels and oils are easily found in the area of operation.

Types of farm machinery

There are three broad types of machinery based on what they are used for. They include:

- Land preparation machines
- Chemical protection machines
- Agro-processing machines

1. Land preparation machines

There are two types of machinery that are used for land preparation and these are:

- Human or animal power dependent machines
- Tractor-drawn or mounted machines

a. Human or animal power dependent machines

These are machines that depend on either human or animal power to work. Some of them include:

- Mouldboard plough
- Ridger
- Cultivator
- Ox-cart
- Sickle
- Wheelbarrow
- Hoe

- Panga knife

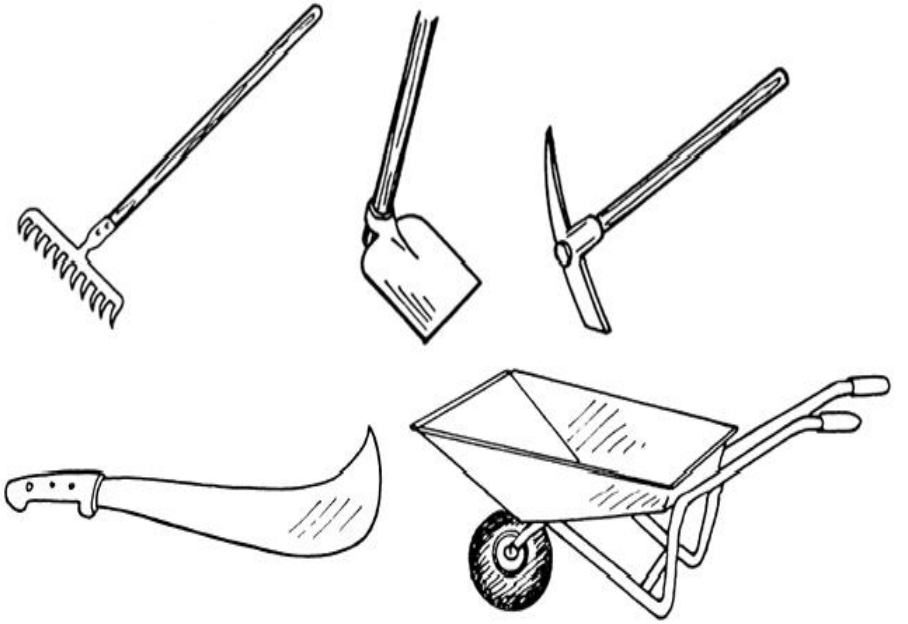

Fig. 4.1 Examples of human dependent machines

In this book we will just cover some of them in the paragraphs below.
Plough: A plough is an example of land preparation equipment. It is used to loosen the soil to make it suitable for crop growth. It cuts the soil and turns it to bury residues and weeds in order to facilitate their decomposition. The plough should be set to achieve the required depth and width of the furrow before using it. The mould board is used to separate the soil after being cut by the share. Do not use a plough on a stony piece of land.
The share wears out fast along the bottom edge towards the tips. The share should always be replaced when worn out. You can see that the share is ready for replacement when the share bolts touch the ground when placed

on a flat surface. Apart from the share, also replace any worn out parts on time. The movable parts such as the wheel need to be greased regularly. After use remove any mud and place the plough in a safe and dry place.

Fig. 4.2 a mouldboard plough

Ridger: A ridger is a machine that is used to make planting ridges. It has a wedge winged body which throws equal amounts of soil on both sides. The ridger has the same parts as the plough, only that it has two wings.The wearing parts of the ridger are the share, breast-plate and wings. These should be maintained regularly and replaced when worn out.
Remember to properly lubricate the ridger with oil if it will not be used within five days. If it will not be used for a long time, the ridger needs to be painted with oil paint.

Cultivator: A cultivator is an implement that is used to remove weeds between rows. It does not manage to remove weeds in between planting stations. It can also be used in seedbed preparation to cut, break and loosen the soil. The two types of cultivators are **adjustable cultivators**

and **rigid cultivators**. Adjustable cultivators can be set to suit the width of the plant rows when cultivating the crops. The rigid cultivators cannot be adjusted during cultivation. The cultivator needs to be lubricated with oil if it will not be used within five days.

Ox-cart: An Ox-cart is used as an important means of transport for carrying farm produce and inputs. The following should be avoided:

- The ox-cart must not be overloaded.
- The load should be placed up front on the cart and not on the rear (back). If the load is on the rear, the disselboom will tilt the cart upwards and the straps will choke the animals.

The ox-cart can be maintained in the following ways:

- Checking and making sure that all the bolts and nuts are tight before use
- Cleaning the hubs annually. The hub is a place where the tyre is fitted. Wash the bearings in petrol, diesel or paraffin. When reassembling make sure that there is grease in the hubs. In case where grease is not available, petroleum jelly can be used.
- Making sure tyres are well inflated.

The animals that are used in pulling ox-carts are known as **draught animals**. The following things need to be considered when managing them:

- Provide them with a leak proof house.
- Carry feed such as grass to be given to the animals during work breaks. After working, the animals need to be given concentrates (two to three kilograms is enough per day) and water to drink. Thereafter, the animals should be allowed to graze freely.
- The animals should be allowed to work for a maximum of seven hours per day. They should work for four hours in the morning and

three hours in the afternoon. The animals should preferably work early in the morning and late in the afternoon. These times are considered as cool periods when animals can work comfortably.

- Drought animals should be protected from parasites and diseases. They need to be taken to the dip tank regularly.

Fig. 4.3 An ox-cart

Yokes

A yoke can be defined as a piece of wood that rests on the animals' necks held in position with a rope and wooden brackets. In the centre of a yoke is a hook to which the draught chain is attached. The yoke may be padded where it rests on the necks of the animals to ensure comfort and durability.

The yokes should be properly placed in a shed to prevent damage.The animals can be driven and controlled easily when a nose ring is fitted. Safety when hitching the animals may be improved when horns are capped or filed blunt. The driver is advised not to use a stick to control the

animals but rather train them to obey vocal commands so that you can control the implement properly with both hands.

The lengths of yokes should be different based on the type of implement under use. For instance, the length of a yoke for a plough and farm-carts are different. Cultivators use the same yoke as ridgers. The following are the recommended yoke sizes to be used when cultivating:

- Ploughing yoke

The length of the yoke should be 150cm long. The space between the two pairs of skies on the yoke shaft should be 90cm.

- Ridging yoke

The length of the yoke for ridging depends on the ridging spacing. For a ridge spacing of 75 cm, the yoke length on the shaft should be 210 cm. The space between the 2 pairs of skeis should be 150cm.

Ridge spacing of 90cm requires that the yoke shaft should be 240 cm. The space between the 2 pairs of skeis on the yoke shaft should be 180cm.

For a ridge spacing of 120 cm, total length of the yoke shaft should be 300 cm. The space between 2 pairs of skeis should be 240 cm.

- Transport or cart yoke

The total length of the yoke should be 170 cm. The space between the 2 pairs of skeis should be 110 cm.

b. Tractor drawn or mounted machines

There are some machines that can be drawn by human beings or animals and there are some that cannot be drawn by either. This is because they are very heavy. As such, machines such as tractors are used to draw the implements. Some of these tractor drawn implements are:

- Mouldboard plough
- Disc plough

Mouldboard plough: A mouldboard plough is used when cultivating softer soils and where plant residues should be buried (figure 4.7).

Fig. 4.7 A mouldboard plough

Disc ploughs: A disc plough is capable of being used in fields where there are hidden stones or tree stumps (figure 4.8). This is because the discs can manage to roll over the obstruction (stone or tree stump). In so doing damage of the implement is avoided. The disc plough can also be used in fields with very hard soils and a lot of bush.

Fig. 4.8 A disc plough

Ways of maintaining tractor drawn implements

- Make sure that the tractor has enough fuel.
- Tyres should be properly inflated to correct pressure.
- The battery should be in good working condition.
- Both the steering wheel and the brakes should be in good working condition.
- Bolts and nuts must be thoroughly tightened.

Safety tips when using tractor drawn implements

- Check that the brakes and steering wheel are in good working condition before using the tractor.
- Avoid maintaining the engine when it is running.
- Switch off the engine when fuelling the machine.
- Put uncleaned fuel bottles away from children.
- Check that the tyres are well inflated and in good condition.
- Do not use the tractor when the soil is too wet.

2. Chemical protection machine

Sprayer: A sprayer is an implement that is used for applying chemicals (figure 4.9). This machine is operated using human power. Precautionary measures need to be followed when spraying chemicals with a sprayer since chemicals are hazardous. Some of these measures include:

- Do not spray against wind.
- Wear protective clothing when spraying.
- Avoid eating, drinking or smoking when spraying.
- Never clean the nozzle by blowing with your mouth.

- Wash hands after handling chemicals.
- The sprayer should be cleaned thoroughly after use.

Fig. 4.9 A sprayer

The sprayers can be maintained in the following ways:

- Check components such as pistons, brackets, gaskets, valves and hoses for wear and tear. They should be examined and replaced when worn out.
- Empty the contents of the sprayer and wash and dry it.
- Metal parts such as nozzles and filters should be coated with oil before storage to prevent corrosion. It should be washed before use so that the oil does not tamper with the chemicals.

3. Agro-processing machines

These are machines that are used in processing agricultural products with the aim of adding value and increasing shelf-life. Some of them are hand operated while others need electric power. For instance, a pop-corn maker uses electricity to produce pop-corn. Most fruit juice extractors use human power as they are hand operated.

Chapter summary

- A machine is any device that makes work easy.
- Farmers use machines so that they complete farming activities on time, protect their crops and also process them.
- Some machines can be operated using human power while others need electricity or tractors.
- Machines need to be regularly serviced to make sure that they work properly and prevent accidents.

End of chapter exercise

1. a. What is power?
   b. Mention the sources of power that are of importance to a farmer.
2. a. Define the term 'farm mechanisation'
   b. Mention some of the advantages and limitations of farm Mechanisation.
3. Describe how an ox-cart can be maintained.
4. Explain any **five** safety tips when using farm machines.

CHAPTER 5: IMPROVED FARM TECHNOLOGIES AND GENDER

Introduction

In chapter 4 you looked at some of the machines that are used in agriculture. You learnt that some of them use human power while others are tractor or animal driven. In all these types of machines, a human being is always in control. For many years more men than women have been behind these machines. This of late has been recognized as a problem in agriculture. In this chapter you will look at farming technologies and their connection with gender.

Objectives

By the end of this chapter, you will be able to:

- *Explain the meaning of the term 'farming technology'.*
- *Explain the effects of farming technology on food supply.*
- *Explain the effects of farming technology on food security.*
- *Identify gender biases in agricultural technologies.*
- *Explain causes of gender biases in agricultural technology.*
- *Examine the effects of gender bias in agricultural technology.*
- *Describe ways of dealing with gender bias in agricultural technology.*

Improved farm technology

Improved farm technology refers to any technique that is used in agriculture with the aim of obtaining high yields and protecting natural resources. These technologies have built their foundations on modern scientific and technological approaches. The following are some of the modern agricultural technologies:

Agroforestry: Agroforestry is the practice of deliberately growing or retaining trees or shrubs within an agricultural or pastoral land use system. Trees and shrubs have beneficial effects on soil. Some trees increase soil nutrients by fixing nitrogen. All trees increase soil organic matter, which helps improve the availability of water and nutrients. Tree cover also helps to reduce soil temperature, which decreases evapotranspiration, making more water available for crop growth. All this helps to increase crop yield which in turn boosts food supply and makes people food secure.

Farm mechanisation: The development and use of farm machinery has enabled famers to complete all farm operations such as land preparation, planting, weeding, application of chemicals etc. on time. This helps farmers obtain high yields.

Rainwater harvesting: Rainwater harvesting involves the collection of water for storage. The water may be used for irrigating crops which enables farmers to harvest more even in cases where rainfall is not enough for crop production.

Irrigation technology: The development of irrigation technologies such as drip or basin irrigation has allowed farmers to use water resources efficiently. This enables farmers to have enough food even in drought periods.

Fig. 5.1 Sprinkler irrigation

Crop and animal breeding: The development of high-yielding varieties and breeds of animals is enabling the farm to yield a lot of produce. In addition, pest-resistant and drought resistant crops are also available to farmers to plant.

Fertilizer production: Technology has enabled farmers to use fertilizer that is able to supply the soil with the major plant nutrients such as nitrogen, potassium and phosphorous e.g. Urea and 23:21:0 + 4S. This has enabled farmers to produce a lot of food, thereby ensuring food security.

Conservation agriculture: Farmers are now able to use farming systems that are able to conserve soil and water. Such systems include organic farming and zero tillage. These have allowed farmers to increase and maintain the productivity of the soil, resulting in bumper yields.

Development of balanced rations: Animals such as chickens and cattle are now given balanced rations that are rich in all the required nutrients. This has enabled the animals to produce high yields in form of meat, milk or eggs.

Improvements in animal housing systems: To obtain high yields, animals are now being kept under intensive housing systems. Farmers are able to feed and monitor the performance of the animals and correct it if it is poor. For instance, layers may be kept in a battery cage which is an example of an intensive housing system.

Pesticides development: Technology has resulted in the development of pesticides or fungicides and the best ways of applying them. Crops and animals are now protected, resulting in high yields.

Herbicides development: Weeds are always a problem in farming. There are now chemicals that are able to kill weeds before they cause damage to our crops. This enables farmers to produce bumper yields.
Agro-processing and packaging: Perishables such as fruits, fish and meat can be processed and kept in tins (canning) so that they are stored for a long period. They can be released when demand is high. Packaging enables products to stay longer and also attract customers.

Improved storage facilities: Post-harvesting losses have been reduced due to the development of modern storage facilities such metallic grain silos, fridges, cold rooms etc.

Fig. 5.2 Metallic grain silos

Gender bias and agricultural technologies

Gender refers to the differences between women and men or girls and boys due to social and cultural factors.

Gender bias means the act of favouring one gender category against the other in terms of decisions and actions.

Causes of gender biases in agricultural technology

There are different causes of gender biases in agricultural technologies in Malawi. Some of them include:

a. Unequal power relations

Culturally men are treated as heads of the family. This makes them have more power than women. As such men can decide what technology is to be used on the farm. The men will now have full control of the technology compared to women.

b. Low self-esteem

Most females are raised in such a way that they lack self-confidence. This is because they are given less challenging roles than their male counterparts. This brings problems when it comes to using more advanced technologies such as farm mechanisation. Women should also have a share of challenging tasks from childhood.

c. Limited access to technological information

Technological information is easily obtained when a person is allowed to move freely and also when they are educated. Unfortunately, women are not given a chance to visit places such as agricultural fairs where they can learn about some technologies easily. Their education is also not given a priority, thereby denying them a chance to easily understand the modern agricultural technologies.

d. Lack of access to capital items

Agricultural technological items are very expensive to buy and maintain. Men are more trusted with loans than women. This makes women not have a chance of buying modern agricultural equipment that is suitable for their farming activities.

e. Gender stereotypes

Most people in Malawi believe that some machines are supposed to be used by men or women only. Machines like tractors are believed to be for use by men only, not women. Cultivating using a hoe is left to women. This should not be the case as women can equally use machines that are believed to be for use by males only if they are given a chance.

Effects of gender bias in agricultural technology

Lack of modern technological skills in women prevents them from to finishing farm activities on time. This results in low yields. The low yields result in food insecurity and starvation.

There is also an underutilization of human resources as most women are not equipped with the needed technologies to carry out farm work. This is because men who use the farm machines only do 30% of farm work as compared to women.

Ways of dealing with gender bias in agricultural technology

Activity 5.1

- *Be in pairs.*
- *Brainstorm some of the ways of dealing with gender bias in agricultural technology.*
- Report your answers to the rest of the class for comments.

Compare your answers with the following points:

- Women should be allowed to use machines that people believe are supposed to be used by men only.
- Women should have access to capital items easily.
- Females should be encouraged to go to school.
- Extension services should also be made available to women.

Fig. 5.3 A woman using a treadle pump

Chapter summary

- *Farming technology refers to any technique that is used in agriculture to obtain high yields and protect natural resources.*
- *Agroforestry, farm mechanisation, rainwater harvesting, crop and animal breeding, fertilizer production are some of the modern farming technologies.*
- *Gender refers to the difference between women and men based on social and cultural factors.*
- *Gender bias is the act of favouring one gender category against the other in terms of decisions and actions.*
- *Gender bias in agricultural technologies can cause food insecurity and underutilization of human capital.*

End of chapter exercise

1. What is farming technology?
2. Describe any **five** farming technologies.
3. Define the term ‘gender bias’
4. Explain the effects of gender bias in farming technology

CHAPTER 6: CROP IMPROVEMENT, PROCESSING AND STORAGE

Introduction

The yield that farmers get in a particular farming season depends on several factors. The methods of farming, soil and climatic factors are some of the factors that affect how much the farmer harvests. All these are environmental factors that can be modified by the farmer with the aim of increasing yields. Plant breeders come in by trying to change the genetic make-up of the plants to suit climatic and soil factors of a particular area. This is because there is an interaction between the genotype of a crop and the environment which determines the final appearance (phenotype) of the crop. This means that the phenotypic characteristics of a crop is determined by both environmental and genotypic factors. The phenotypic characteristics include plumpness, colour, shape, height, size, nutrient seed content, etc. Changing the genes and modifying the environment helps to get high quantity and quality of yield. As such proper handling of crops during harvesting and in the storage facility is important to avoid post-harvest losses.

This chapter discusses how improved crop yields can be handled to prevent losses at the farm.

Objectives

By the end of this chapter, you will be able to:

- *Explain the meaning of the term 'crop improvement'.*
- *Describe the aims of crop improvement.*
- *Describe the methods of crop improvement*
- *Explain the meaning of the term 'crop processing'.*
- *State the importance of crop processing.*

- *Describe how to process some selected crops*

Meaning of the term 'crop improvement'

Crop improvement refers to the act of changing the productivity of cultivated crops through the development of better cultivars. These cultivated varieties (cultivars) contain superior traits (characteristics). Crop improvement started a long time ago and the skills have been changing over the years. In ancient times farmers could select crops with desirable traits, collect their seeds and keep them for the next growing season. This act qualifies the ancient farmers to be called the first crop breeders.

Objectives of crop improvement

Activity 6.1

- *Be in pairs.*
- *Brainstorm some of the reasons why most farmers use improved varieties of crops as opposed to local varieties.*
- *Report your answers to the rest of the class for*

Crop breeders take time to improve the characteristics of different crops for several reasons. Some of them are:

- **To help in improving the resistance of crops to pests and diseases**: Due to the increased cases of pest and disease attacks, breeders have managed to develop crop varieties that are able to resist attacks by pests and diseases. For instance, RG 1 groundnut variety was developed with the aim of dealing with rosette as it is resistant to this disease.

- **To increase growth of the vegetative matter (biomass) of a plant**: The improvement of this trait is very useful to farmers who keep ruminant animals such as cattle, goats and sheep. It may be achieved to forage crops thorough an increased growth rate, greater plant vigour or fast recovery after grazing (cutting).
- **To improve the ability of the plant to direct the manufactured food to the harvestable parts:** Examples of these harvestable parts are the root tubers (e.g. sweet potatoes), stems (e.g. sugarcanes), leaves (e.g. cabbage), fruits (e.g. oranges), and seeds (e.g. legumes).
- **To improve crop tolerance to harsh climatic conditions**: Due to climate change, crop breeders need to come up with crop varieties that are able to withstand extremely poor climatic conditions so that they still give high produce. Such harsh climatic conditions that crops may be bred to withstand are draught, hail, cold and wind.
- **To have crops that can mature within the growing season regardless of its length:** Some areas have a short growing season while others have a long one. Breeders have come up with crops that can be planted in either places and mature without a problem. For instance, MH18 which matures in within 110 to 120 days is an early maturing maize variety which is suitable for low altitude areas of Malawi.
- **To achieve crop and product uniformity**: Crop breeders also strive to achieve uniformity in terms of seed germination time, growth rate, flowering time, fruit size, crop height and crop maturing time. Uniformity is very important for the following reasons:

- farm machines can be used easily when weeding and harvesting.
- reduces grading costs in terms of time and money for labour since the products are already more or less uniform in various aspects.
- crops mature and are harvested within the same period thereby reducing labour and transport costs.

- **To promote dwarfness in fruit trees so that they can easily be harvested**: Fruits from tall trees are difficult to harvest through hand picking which is the most recommended way of harvesting fruits.
- **To improve quality of raw materials**: Many agricultural products are raw materials for different products once processed. Cooking oil manufacturers need high oil content groundnut seeds and sugar manufacturers may need sugar canes with high sugar content.
- **To improve the marketing qualities of agricultural products:** Most consumers need products of good colour, texture, taste and those that can be stored easily for a long time.
- **To increase the nutritive value of crop products:** Crop products should contain more nutrients such as proteins, fats or carbohydrates. This makes them to be easy to use in preparing balanced diets and balanced rations for humans and livestock respectively.

Methods of crop improvement

There are three methods that can be used during crop improvement. These are:

- Introduction.
- Selection.
- Hybridisation.

Crop improvement through introduction

Introduction is a direct method of obtaining crops with superior traits by importing them from other countries. The introduced varieties will act as a source of new genes which can be manipulated by crop breeders. The imported varieties need to be kept in quarantine for some time to avoid the introduction of new pests or diseases which may come together with them. The site of crop origin and the area where it is to be introduced should have similar environmental conditions. This enables the crop to get established easily. This is why testing is also done after removing the crop from the quarantine in order to see how the crop performs.

Most of the successful crop species and varieties used in Malawi have been obtained in this way. For instance, Ukirigulu Composite A (UCA) which is a maize variety was imported from Tanzania. Even some groundnut varieties such as Blue bonnet were imported from USA.

Crop improvement through selection

This method involves choosing crops with the most desired traits (characteristics) for breeding or propagation. This method basically uses the genetic idea that some traits are inherited from parents to off-springs. This makes farmers select only seeds from parents with superior traits. Selection is mostly used to improve the suitability of a crop to a specific environment. It does this by improving the already existing superior traits but not introducing any new desirable traits.

Some of the ways that are used when selecting crops for breeding are as follows:

Mass selection: This technique involves choosing and collecting seeds from a large number of crops displaying desired traits from different

fields. The seeds are put together (mixed); this is called bulking and used to plant the next season's crop. From this crop a further selection may be made and the seed used to establish a succeeding crop. Because the seed is mixed, this method permits no selection to be made on the basis of performance of the progeny (the field from where the seeds were collected) of a particular parent plant.

Single plant selectionis a type of selection in which individual crops are chosen for breeding. The crops selected from the fields are only those with desired traits. Seeds from these plants are collected and used for further observation and selection.

Crop improvement through hybridisation

Hybridisation consists of crossing two varieties of crops with the objective of producing a new variety which combines characteristics from each of the parents. Crossing of plants from two different varieties produces a hybrid in which the genetic material from both parents is represented.

The production of hybrid varieties in maize is relatively simple, because the flowers are unisex. The ears (cobs) contain only female flowers and the tassels only male flowers. In order to produce hybrids between two varieties, it is important to prevent chance pollination. This is done by placing a bag over the ear before the stigmas emerge (silking). Then the bag is briefly removed when introducing the pollen from the chosen male parent. The anthers may also be removed or be killed before they mature. This is known as emasculation.

During hybridisation three important steps are taken. These are:

Choosing parents: The plant breeder chooses parental varieties that have desired traits that are able to complement each other. For instance, a crop

that is high yielding but susceptible to pests may be crossed with a low yielding variety that is resistant to pests.

Self-pollinating the parents: The chosen parents are self-pollinated. This is what is known as inbreeding. Continued inbreeding produces a clearly visible and progressive reduction in height, loss of vigour (inbreeding depression), and decrease in yield. The reduction in height stops after about five generations of inbreeding. The reduction in yield may stop after about twenty generations of inbreeding. However, true-breeding lines may be selected after 4 or 5 years of inbreeding.

Crossing the true-breeding lines: This involves the manual collection and transfer of pollen from one inbred to the stigma of the other inbred. When crosses are made between suitable inbred lines, and the hybrid seeds are planted, the plants from these seeds are taller, more vigorous, and higher yielding than the original open-pollinated varieties from which the hybrids were produced. This results from heterosis or hybrid vigour.

Meaning of the term 'crop processing'

Crop processing refers to all activities that are done with the aim of changing agricultural items from one form to another. Basically, processing involves the changing of raw materials from one from to another form.

Importance of crop processing

Crops are processed for the following reasons:

- **To improve shelf-life**: Most agricultural commodities are seasonal and perishable as such they are processed so that they can be kept for a long time. This enables them to be sold at a higher price since demand is always high at this time.
- **For easy transportation:** Agricultural products are very bulky when they are in raw form and they become lighter when

processed e.g. pine apples are lighter when processed into juice than carrying the fruits.

- **To add value to the product:** Agricultural products are cheaper when sold in raw form unlike when processed e.g. tomato fruits are cheaper than tomato sauce.
- **To improve taste:** The taste of some agricultural commodities such as groundnuts is improved when processed into peanut butter as some ingredients are added.

Methods of processing maize for storage

Maize is Malawi's staple food. As such, its processing methods need to be looked at seriously as much of it is lost through post -harvesting losses. These losses result in food insecurity. The following are some of the activities that are done when processing maize for storage:

a. Removing the maize cob sheath

This step involves removing the husks of the maize cobs. It may be done during harvesting or soon after harvesting (figure 6.1). In the past most smallholder famers used to store their maize in granaries without removing the husks. The maize was being kept like this since most of the farmers were harvesting it while it was fully dry. The farmers also argue that the local maize varieties they were using were very resistant to storage pests and there was no need to remove the husks which could make the application of pesticides difficult.

In these modern times due to an increase in demand for the staple food and increase in cases of theft, farmers harvest their maize while it has not fully dried. This forces them to remove the maize husks for the following reasons:

- To allow air and heat to freely reach the grains for fast drying.
- To get rid of moisture content. Husks may prevent fast drying and encourage mould growth.

- For easy application of pesticides to the grains on the maize cobs.

The removed maize husks should not be burnt, but they can either be given to livestock such as cattle or left in the field to decompose.

Fig. 6.1 Maize cobs with husks removed

b. Shelling the grain

Shelling the grain involves removing the maize grains from the cobs. This can be done manually using hands or some special machines. Shelled maize dries faster than unshelled one. This is because the cob may contain some moisture which affects the drying of the grains. Shelled maize also requires less storage space. The empty cobs are now well dried and may be used as wood for cooking.

Fig. 6.2 Shelled maize

c. Drying the grain

Maize grains need to be dried thoroughly. Most smallholder farmers sun-dry their maize grains by spreading them on mats, big rocks, or concrete floors. Avoid drying the maize direct on the soil as it becomes difficult to dry since the soil still has a lot of moisture soon after harvesting. It also becomes difficult to collect and clean the maize grains. The grains are spread at regular intervals to ensure that all grains have access to the sunlight energy. The maize grains should also be protected from chickens that are kept under the free range system.On a commercial scale, maize grains are air-dried in big buildings where air is regulated. The maize grains should not be over-dried. They should be dried to between 10 – 12% moisture content. When you see cracks know that the grains have been over-dried.

Maize grains should be thoroughly dried for the following reasons:

- To avoid germination of grains in storage.
- To prevent mould formation on the scar.
- To help in preserving the stored food in the grain by reducing the rate of respiration.

d. Cleaning

Once the maize grains have dried they should be cleaned thoroughly. Shelled maize is cleaned by winnowing using a winnower to remove chaff.

e. Grain milling

The clean shelled maize can be taken to a maize mill where it will be changed into maize flour. The maize bran is removed before the grains are changed to flour. Some vitamins such as vitamin A and minerals such as iron and zinc may be added to improve the nutritional value of the maize flour.

Storing maize grains or flour: Shelled maize and maize flour can be stored in clean sacks, tins, baskets or drums. The unshelled maize can be stored in granaries.

Once the maize grains or flour have been put in sacks, tins or drums it should be placed in a grain or flour store. The grain or flour store should have the following qualities:

- It should be leak-proof.
- It should have strong walls.
- It should be clean and dry.
- It should be well ventilated.

Methods of processing groundnuts for storage

Groundnuts can be stored while shelled or unshelled (in pods).Groundnuts are dried and cleaned in the same way as maize. Groundnuts should be kept in a dry place to prevent development of moulds.

Groundnuts can further be processed into peanut butter and packed in bottles for sale. It can also be roasted and packed in packets and bottles.

Methods of processing mangoes

Mangoes as most of the fruits are very perishable. The common methods of processing them are canning, freezing, and preparing them into juices.

Canning: Canning is a process where mangoes are put in sealed or air-tight containers and then heated to a high temperature. The heat will kill microorganisms which cause the fruits to go bad during storage. The problem with this method is that, it changes the flavour, colour, texture and nutritive value of the fruit.

The process of canning mangoes can be carried out as follows:

- Pluck fresh mango fruits of the best quality from your trees.
- Sort the fruits by removing those that are bruised, over-ripe or damaged by pests and diseases.
- Thoroughly wash the fruits with clean water, making sure that all dirt is removed.
- Peel the fruits and then slice the large ones into small pieces.
- Dip the fruits in ascorbic acid (vitamin C) or lemon juice to preserve their colour, flavour and texture.
- Place the sliced fruits in sterilised metal cans or glass jars and close or seal them tightly.
- Steam or heat the fruits in boiling water for about 10 minutes. Then take cans or jars out of the boiling water and put them in a cool dark place.

- When the tins, cans or glass jars are cool, label them to show their contents and the date when canned.

After canning, ensure that the seals on each container are air-tight. If canning has been carried out properly, the fruits can retain eating quality for a long time.

Freezing: Freezing involves putting mango fruits in a freezer where temperatures are below 0^{o}C. Under this temperature, microorganisms become inactive and cannot multiply. Frozen fruits will retain eating quality for many months.

To process mangoes by freezing, you need to do the following:

- Sort the mango fruits and remove those that are spoilt.
- Wash the fruits thoroughly with clean water to remove dirt.
- Put them in a plastic bag and place them in the freezer.
- Leave them to freeze.

The above steps will also apply if the mango fruits are to be kept in a refrigerator. In the refrigerator, the temperature will be from 1^{o}C to about 24^{o}C.

Methods of processing vegetables

Vegetables are both perishable and seasonal as such they need to be processed. Green leafy vegetables such as rape can be kept in a refrigerator. They need to be thoroughly cleaned and placed in a plastic bag. Then they are placed in the refrigerator. It is not recommended for green leafy vegetables to be boiled and later on dried as most of the nutrients and vitamins such as vitamin A are lost in the process.

Some vegetables such as beans and peas can be processed by canning, drying, freezing and refrigeration. Fresh beans and peas are more

nutritious than those that have been kept for some time. You can use the processing methods mentioned if there is no immediate market.

Methods of processing mushrooms

Mushrooms are also very perishable and seasonal. However, the problem of seasonality has now been dealt with due to the introduction of cultivated strains such as Oyster. Mushrooms need to be carefully cleaned as they are delicate. They can later be canned, frozen or refrigerated.

Activity 6.2

Your teacher is going to choose one crop so that you process it. Be prepared to take part in the activity. Remember to list down some problems that you may face during the activity.

Chapter summary

- *Crop improvement refers to the act of changing the productivity of cultivated crops through the development of better cultivars.*
- *Crops are improved to improve their resistance to pests and diseases, increase growth of vegetative matter of a plant, achieve crop and product quality, improve quality of raw materials, promote dwarfness in fruit trees, improve marketing quality of crops and increase the nutritive value of crop products.*
- *Crop processing refers to all activities that are done from the time of harvesting till the product is ready for consumption.*
- *Crops are processed so as to improve shelf life, add value and improve taste.*

End of chapter exercise

1. a. Define the term ‘crop improvement’.
   b. Explain the objectives of crop improvement.
   c. Describe the **three** methods of crop improvement.
2. a. What is crop processing?
   b. Explain any four reasons for crop processing.
3. Describe how the following crops can be processed:
   a. Maize
   b. Mango fruits
   c. Vegetables
   d. Mushrooms

CHAPTER 7: MANGO PRODUCTION

Introduction

Long ago people relied only on gathering fruits and hunting wild animals from their environment. Fruits still remain an important source of food for human beings. They are mostly taken after a main meal of the day e.g. lunch. They are the healthiest natural foods and a foundation to a healthy diet. Some of the fruits are indigenous while others are exotic. One of the main types of fruits produced in Malawi is the mango. There are both indigenous and exotic varieties of mangoes. This chapter will concentrate on the activities involved in the production of mangoes.

Objectives

By the end of this chapter you will be able to:

- *State the importance of fruits.*
- *Identify different varieties of mangoes.*
- *Select a suitable site for mango production.*
- *Prepare a site for transplanting mango seedlings.*
- *Transplant mango seedlings.*
- *Describe how to weed a mango orchard.*
- *Identify pests and diseases of mangoes.*
- *Explain how to control diseases of mangoes.*

General importance of fruits

Activity 7.1

- *Individually list down some of the reasons why fruits are important to human beings.*
- *Prepare to report your answers to the rest of the class for comments*

Your list may contain some of the following points:

- Source of vitamins, minerals, carbohydrates and fibre. Vitamins and minerals help protect us from diseases. Fibre helps us to avoid constipation since it helps in digestion. Carbohydrates are a very good source of energy.
- Fruit contains a lot of water required by our bodies, is naturally sweet, low in fats, and is cholesterol free.
- Fruit adds variety, colour, texture and flavour to a dish.
- They are a raw material for jams, juices, some alcoholic drinks and medicines.
- Fruits are sold to earn money. If exported, they can earn a country foreign exchange.
- The harvesting, processing and marketing of fruits create employment for some people.

Cultural practices for mango production

Mangoes (*Mangiferaindica*) are common fruits found in the country. They do well in warm to hot areas with altitudes ranging from 0 to 750 m above sea level. Areas where mangoes do well should have well defined wet and dry seasons. Mango yields are low in cool areas due to high incidences of a mango disease known as powdery mildew. There are both indigenous and exotic varieties of mangoes.

Cultural practices are all the activities that are done to ensure that high yields and quality mango fruits are produced.

The following are some of the cultural practices that are recommended for the production of high quality mangoes:

a. Use of recommended mango varieties

It is very important to select a suitable variety of mango to be planted in order to have high quality mangoes. Table 7.1 shows some of the recommended improved (through grafting) exotic mango varieties.

Table 7.1 Improved mango varieties and their characteristics

Improved varieties	**Characteristics**
Haden	• They are big and oblong shaped • Sweet • Purple colour skin which becomes lighter when ripe
Tommy Atkins	• Medium sized and oblong shaped • Very sweet • Deep purple colour when approaching maturity
Kent	• Medium sized and oval in shape • They are moderately sweet • They turn red orange from the stalk at maturity
Davis Haden	• Medium sized fruits • Sweet • Have orange skin colour when ripe
Irwin	• Small sized fruits weighing close to 150 grams each • They are sweet • Deep purple skin colour when close to maturity

On average the above improved mango varieties can yield between 200 to 500 fruits per fully grown tree.

There are also some local varieties that farmers can plant in their orchards. They yield more mangoes per tree as opposed to the improved ones. The only problem with them is that they have a high fibre content and large stones. These qualities make them unpopular in foreign markets.
Examples of these local cultivars are *Boloma* and *Domasi* which are big and sweet. There are also small and sweet mangoes such as *Waka*, *Nthulura* and *Kapantha*. These local varieties are well adapted to the local environmental conditions.

b. Site selection and field preparation

Soils should be deep, relatively fertile and well drained. The planting holes should be prepared 2 months before planting. The holes should be 90 cm in diameter and 90 cm deep. When constructing the planting holes make sure that you put top soil separate from subsoil. The top soil will be used for filling the hole while the subsoil will be used for making the basins around the tree. Remember to mix the top soil with 5 to 10 kg of well decomposed manure before filling the hole.

c. Transplanting mango tree seedlings

Mango trees are first sown in the nursery where they are cared for before being transferred to the field. Mango seedlings should be transplanted in December or January for the easy establishment of the transplants. The trees should be spaced at 9 m × 9 m, 10.5 m × 10.5m or 12 m × 12 m depending on the variety, type of soil and other environmental factors. Mango seeds may be sown in polythene tubes or direct into the nursery bed where they will be called bare-rooted seedlings.
The following are some of the activities that are done when transplanting a mango seedling from a polythene tube:

- ❖ Cut and remove the polythene bag around the roots of the seedlings. Be very careful not to destroy the roots and the ball of soil around the roots.
- ❖ Partially fill the hole with a mixture of top soil which has been mixed with the well decomposed compost manure. Leave enough space for the seedling so that when planted, the top part of the ball of the soil is level with the surface of the hole. If the top part of the ball of soil is below or above the surface of the hole, then reduce or increase the mixture of the top soil as applicable.
- ❖ Place the seedlings in the centre of the hole. Ensure that the top part of the ball of soil is level with the surface of the hole or surrounding ground level.
- ❖ Fill the space around the seedling with the mixture of top soil and compost manure until the ball of soil around the roots (root collar) is completely covered. Firmly press down the soil around the ball of the soil in order to remove air pockets and to keep the seedlings firmly upright.
- ❖ Use the sub-soil or left over top soil to build a basin around the fruit tree seedling. Then water the seedlings immediately after constructing the basin. Use a watering can with a fine rose when watering for the first time to prevent the digging of the soil by the water.

Bare-rooted seedlings can be transplanted in the following ways:

- ❖ Push a hand trowel into the soil in the nursery about 10 cm away from the seedling you want to transplant. Make sure that the trowel does not damage the roots of the seedlings.
- ❖ Turn the hand trowel upwards such that it removes the seedling together with the ball of soil around its roots.

- ❖ Take the seedlings to the prepared hole and plant it immediately. Follow the same steps when planting as those outlined above.

d. Mulching

Area around the mango tree should be covered with suitable mulch to conserve water. This is very important in places where the temperatures are very high and water is a problem.

e. Cultivation of the soil

Some months after transplanting the fruit trees into the field, the soil around the trees in the basins may become compact. Regular cultivation is necessary to loosen the soil and enable water and air to get in easily. Cultivation also helps to kill weeds by exposing them or their seeds to harsh conditions.

f. Manure and fertilizer application

Even though the soil in an orchard may have been fertile at the time of planting the trees, with passage of time, the nutrients are used up. It is therefore important to regularly observe trees to see if they are showing any deficiency signs. If deficiencies are seen, relevant fertilizers should be applied to enable the trees to grow well.

When mango trees start producing fruits, adding fertilizers containing potassium such as muriate of potash and potassium sulphates will help improve the quality of fruits. Adding superphosphate helps fruit trees to produce strong roots which reduce lodging of trees. At the beginning of each rainy season apply 5 to 10 kg of compost manure which help to improve organic matter content in the area around the trees.

g. Weed control

The area inside the basin should be kept weed free as much as possible. The rest of the area outside the basin should be regularly slashed. The weeds should be removed as soon as they appear. This is because they compete with our fruit trees for water, nutrients and space. As a result, our fruit trees end up growing poorly and producing few fruits of lower quality. The weeds are also a fire hazard when dry. Bush fires can destroy our fruit trees if they happen to occur in our orchard. The weeds can also attract insects that may end up destroying our fruit trees and the real fruits.

h. Controlling pests and diseases

The growth of fruit trees is heavily affected when attacked by either pests or diseases. They may cause damage to fruits or fruit trees. The pests and diseases need to be controlled before they cause damage to the fruits or fruit trees.

The common insect pests that attack mangoes and how they can be controlled are presented below:

- Mango stone weevil (*Sternochetusmangifera*)

This pest causes damage to a seed. The larva of the insect enters the fruit during the early stages of fruit development. This makes it difficult to know that the insect has entered the fruit as there is no sign of its entry.

The major signs of mango stone weevil attack are premature fruit fall, fruits rotting in storage, in transit and markets. The pest can be controlled by collecting and burying all dropped and rotten fruits.

- Scales (*Coccus mangiferae* and *Coccusacuminatus*)

The scales appear on the leaves and fruits. They can be controlled by spraying Dimethoate 20WP85g in 14 litres of water.

- Fruit fly (*Ceratitiscapitata*)

The larva damages the fruit causing fruits to fall from the tree prematurely. They can be controlled by regularly collecting and burying dropped fruits. The mangoes should also be harvested when they are physiologically mature to control fruit flies. Chemical control of the insects may be achieved by spraying of Fenthion (Lebaycid) 50 EC at the rate of 1ml per 2 litres of water weekly. Alternatively, a poison of 20 g of Trichlorphon (Dipterex) 50 WP mixed with brown sugar in 20 litres of water should be applied to the leaves (foliage).

Some of the diseases that attack mangoes are:

- Anthracnose (*Glomerella cingulate*)

The disease causes loss in colour (discolouration) of young leaves, premature ripening and enhanced rotting of fruits. The disease can be controlled by spraying Benomyl (Benlate) 50 WP at a rate of 15g in 10 litres of water.

- Powdery mildew (*Oidiummangiferae*)

This is a fungus that invades flowers especially in moist conditions. It results in shedding of flowers and young fruits. The disease can be controlled by spraying Benomyl (Benlate) 50 WP at a rate of 15g in 10 litres of water.

i. Pruning

Pruning involves the removal of unwanted fruit tree branches. Pruning is aimed at reducing the number of branches that will be fed by the tree through photosynthesis. The remaining branches will grow strong and produce fewer but high quality mangoes. Pruning also opens up the canopy to allow free movement of air and easy penetration of light to the inner parts of the tree. This helps in photosynthesis and ripening of fruits.

Harvesting mangoes

Mango fruits should be harvested when they are physiologically mature (*Kudengula* or *kuyezuka*). They may be harvested using hands (hand-picking). Hand-picking is done to prevent bruises on the fruit and prevent the contamination of fruits once they reach the ground.

Hand picking takes much time and requires a lot of people to carry it out. It is also difficult for hand pickers to harvest mangoes from tall mango trees. Where ladders are used, pickers are at a risk of falling down and getting injured. Hand harvesting is however cheaper than machine harvesting, hence it is used by most small scale mango producers.

Machines can also be used to harvest fruits especially if produced on a large scale. This is done so as to harvest fruits more quickly. Some machines are designed to pick individual fruits from trees while others just shake the trees, then the fruits fall into containers placed under the tree.

Processing mangoes for storage

Refer to chapter 6 on how mangoes can be processed.

Activity 7.2

With the guidance of your teacher choose a suitable place for the establishment of your school orchard.

Chapter summary

- *Mangoes are very important in the sense that they provide us with nutrients, raw materials, income, employment and foreign exchange.*
- *Farmers in Malawi grow both local varieties e.g. Boloma and improved varieties e.g. Kent.*

- *Mangoes should be grown in either December or January for easy establishment.*
- *The planting holes should be 90 cm × 90 cm and they should be spaced at 9 m × 9 m or 12 m × 12 m*
- *Mango trees should be weeded, mulched, fertilized, and protected from pests and diseases.*
- *The common mango pests are mango stone weevil, mango scales and fruit flies.*
- *The most problematic diseases are anthracnose and powdery mildews. The two diseases can be controlled by spraying Benomyl 50 WP.*

End of chapter exercise

1. a. Mention any **three**reasons why fruits are important.
   b. List any **two** common examples of fruits that are cultivated in your area apart from mango fruits. (one example should be indigenous and another exotic).
2. a. Name three examples of improved and local varieties of mangoes Respectively.
   b. Mention a reason why our local varieties of mangoes may not be marketable in foreign markets.
3. Explain the husbandry practices involved when cultivating mangoes.

CHAPTER 8: PASTURE PRODUCTION

Introduction

Natural grasses, legumes and bushes make up the readily available and cheapest source of food for ruminant animals. The examples of these ruminant animals are cattle, goats and sheep. However, the problem with these natural pastures is that they have a limited carrying capacity. Also grazing land is becoming small due to an increase in human population and environmental degradation as most of this grazing land is found on customary land. This gives livestock farmers an opportunity to identify and utilize more productive types of pasture for their livestock.

Objectives

By the end of this chapter, you will be able to:

- *Explain the meaning of the term 'pasture'.*
- *Explain the importance of pasture.*
- *Describe the methods of establishing pasture.*
- *Explain the advantages and disadvantages of each method of pasture establishment.*
- *Describe the procedure for establishing pasture.*
- *Establish pasture following the recommended procedures.*
- *Describe the methods of managing pasture.*
- *Describe the methods of conserving pasture.*
- *Describe the factors that affect the quality of conserved pasture.*

Meaning of the term 'pasture'

Pasture refers to grass, legumes and other bushes that are used as feed for ruminant animals. Do you remember what ruminant animals are? If not just revise your junior certificate agriculture.

Importance of pasture

The following are some of the reason why pasture is important:

- Pasture is the cheapest source of feed for ruminant animals as compared to commercial feeds.
- The use of leguminous pasture in crop rotations helps to improve and maintain soil fertility as they are able to fix nitrogen into the soil. The nitrogen may be used by the successive crop.
- Pasture helps to reduce soil erosion by reducing the speed of running water, intercepting rain drops and binding the soil with their roots.
- It helps to improve and maintain soil structure when the roots and leaves decay to form organic matter.
- It helps in reducing carbon dioxide concentration in the atmosphere by absorbing it, thereby preventing climate change.
- It helps in breaking the life cycle of pests and diseases when included in crop rotations. For instance, love grass and katambora Rhodes grass control eelworms when included in tobacco rotations.

Types of pastures

There are two main types of pasture which are:

a. Natural pastures.
b. Cultivated/improved pastures.

Natural pastures

Natural pastures are indigenous pastures that are found in the uncultivated areas of land such as dry lands or dambos. These pastures are nutritious and palatable when young and leafy. When they reach maturity they become less palatable due to high fibre content and low protein content. Their only advantage is that they are readily available to everyone as they are found on customary land where control is limited. They are a good example of a common pool resource. Examples of natural pastures include thatching grass (*Hyparrhenia*) , Rapoko grass (*Eleusineindica*), and cat's tail grass (*Sporobolus*).

Cultivated or improved pastures

Cultivated pastures are planted pastures that include at least one improved species of grass or legume. These cultivated pastures may be grouped based on the time they take to grow in the field. There are temporary pastures and permanent pastures.

Temporary pastures are also known as **leys**. They last for a period of between 3-5 years. Temporary pastures may consist of a pure stand of grass; legume or the two may be interplanted in one stand. Examples of temporary pastures include Rhodes grass, Guinea grass, Napier grass and Love grass.

Permanent pastures may last for a period of between 10 – 15 years when well managed. They consist of at least one improved or introduced species of grass or legume. Examples of permanent pastures are Start grass (*Cynodondactylon*), Bushman, Mine panic grass, Buffel grass and Torpedo grass.

Advantages of improved pastures over natural pastures include:

- They have higher protein content. This is basically true in legume pastures.

- They remain palatable and easy to digest for a long time as they take time to mature and flower.
- They have a higher dry matter yield than natural pastures.

Methods of establishing pastures

There are different methods of sowing pastures in the field. Farmers may use seeds or vegetative material to establish pasture.
Seeds can be sown by using the following methods:

Broadcasting: Broadcasting involves the spreading of pasture seed on the surface of the soil. It may be done by using hands or a fertilizer spreader. Then the seeds are covered with soil. The broadcasting method is mostly used with pastures with tiny seeds. To make the broadcasting of the seeds easy, the seeds are mixed with sand, saw dust or even fertilizer. These substances that are mixed with the seeds are known as **diluents**.
The broadcasting method has the following **advantages**:

- It is the fastest way of sowing seeds.
- It does not require a lot of labour to carryout.
- It does not require much skill to use the method.

The method also has the following **disadvantages**:

- It is very difficult to spread the seeds evenly on the surface of the soil. This may result in the overcrowding of plants causing competition for light, water, space and nutrients.
- Plants grow in broadcasted fields without following a pattern making weeding, mechanization, and fertilization application difficult.
- Some seeds may not be covered with the soil as such they may be picked up by birds or carried away by water running on the surface of the soil.

- Some seeds may be buried too deep into the soil making them unable to germinate as light may not reach them.

Drilling: The farmer makes drills or trenches using small sticks. The pasture seeds are now placed in the drills then covered with some soil. In some cases the drills may be made using some machines. A good example of such a machine is a planet junior 300A seed drill.
The use of drills has the following **advantages**:

- It is very easy to use machines and apply fertilizer to the plants since there is a distance between drills and plants.
- Seed wastage is minimized as all the seeds are carefully buried.

The method also has the following **disadvantages**:

- It is time consuming when farmers do it manually.
- The use of a machine can be expensive for most smallholder farmers.

Oversowing: Oversowing involves introducing pasture into already existing pasture lands. Oversowing is also known as sod seeding.
This sowing method has the following **advantages**:

- Improved pastures can be introduced in natural pastures which improves their nutritional value.
- Introduction of legume pastures in natural pastures improve their growth rate
- This method ensures an improvement in the variation of pasture land which helps the livestock to choose which type to graze on.

What do you think are the **disadvantages** of this method of sowing pasture?

Undersowing: This method involves combining pasture and an arable crop on the same piece of land. The pasture is planted after an arable crop is well established. For instance, a farmer can grow Love grass in a maize (*Zea mays*) field.

Undersowing has the following **advantage**s:

- The pasture is carefully cared for in the process of managing the arable crop.
- It helps the farmer to have a lot of benefits as she is able to get food from the arable crop, livestock feed and biologically conserve the soil.
- The use of leguminous pastures also improves the nitrogen status of the soil for the benefit of the arable crop.

Undersowing has the following **disadvantages**:

- The two sets of plants may compete for soil resources such as water and nutrients.
- Requires some skill in combining the two sets of plants to reduce or avoid competition.

Vegetative propagation: The vegetative propagation is method involves the use vegetative materials such as stem cuttings or root cuttings. The stem cuttings are also known as setts while the root cuttings are called splits.

Examples of pastures that can be established from splits (roots) include star and Rhodes grass. Napier grass is propagated using stem cuttings (setts).

Vegetative propagation has the following **advantages**:

- The pasture becomes ready for use early as it assumes the age of their parent plants.

- There is genetic uniformity in pasture plants since they resemble their parents.
- The problem of seed dormancy which is common in pasture seeds is avoided.
- Pasture gets established easily since it uses the food reserves in the planting material.
- Vegetative material such as setts or splits may be obtained at a low cost or even freely

The **disadvantages** of vegetative propagation are:

- Vegetative planting materials are mostly bulky.
- The method has high chances of transferring pests and diseases to the off-springs.
- The planting materials used in this system are very difficult to store so that they are used in the next growing season.
- This technique needs special skill in using some methods such as grafting or layering.

Procedure for establishing pasture

When a farmer wants to establish pasture by using any of the above methods, she is supposed to do the following:

Land preparation

The site should be made free from unwanted grass, some trees and their stumps. This should be followed by ploughing and breaking of large soil lumps. The farmer should make sure that the site is prepared early in the dry season to ensure that planting is done on time. What do you think are some of the advantages of early land preparation?

Fig. 8.1 Well prepared land for pasture establishment

Selecting suitable pasture grass and/or legume

There are some factors that a farmer should consider when choosing a type of pasture to plant. Some of them are as follows:

a. Adaptability to the environment

A farmer is encouraged to plant pasture that will easily adapt to the environmental conditions of the area. The farmer should know that plants perform differently under different environmental conditions. For example *Leucaenaleucocelphala* is not adapted to west Mzimba but is well adapted to Lilongwe plain.

b. Feeding value

The type of pasture to be planted should have a high feeding value throughout its life span. Some pastures which lose their feeding value after flowering or which depend on the season are considered less beneficial.

c. Expected duration of the pasture

Some pastures can be used as permanent pastures while others as temporary pastures. The farmer should choose the type of pasture depending on her plan.

d. Compatibility with desired pasture species

A farmer should choose only those species that will be able to successfully grow together in case she wants to establish a mixed stand. Legume pasture species such as silver leaf and siratro with a climbing habit can be mixed with taller grass pastures. The shorter legumes such as stylo and lotononis can be grown together with shorter grass pastures.

e. Suggested method of utilization of the pasture

Pastures may be used in different forms. They may be used while fresh or dry. The type of pasture to be grown should depend on the form in which the pasture will be used.

f. Resistance to local pests and diseases

Pests and diseases have a high potential of reducing pasture yields and quality. Only those pastures that are resistant to pests and diseases should be grown. For instance, in areas where nematodes are a problem sirato (*Macroptiliumairopurpureum*) may be grown. The resistant species are also suitable in crop rotations in order to control some pests such as nematodes and eelworms.

g. Yield per unit area

Those pastures that are able to give a high yield per hectare should be grown as opposed to low yielding pastures.

Selecting pasture seed

Once the type of pasture has been selected the farmer should now concentrate on the pasture seeds. The farmer is advised to use only certified pasture seed when she wants to establish pasture. Certified seed is believed to be quality seed which meets all the required standards. Seed quality is normally expressed as the pure line seed content (PLSC) and is calculated as follows:

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

Farmers can buy pasture seeds and seedlings from Chitedze Research Station in Lilongwe and Land Resource Department.

Planting/sowing

Pasture should be sown as early as possible with the first rains. This is mostly between December and January. The farmer should make sure that quality seeds or vegetative materials are planted. Farmers are strongly advised to use certified seeds that can be obtained from registered agro-dealers. Certified seeds have all the needed qualities of good seeds. What do you think are some of the qualities of a good seed?

One of the qualities is that the seeds should be able to germinate (viable). However, some seeds may fail to germinate not because they are not viable but they have a condition called **dormancy**. A dormant seed is the one that may fail to germinate even if all the required conditions are available. These suitable things required for a seed to germinate are moisture, air and warmth. A farmer can provide these to a seed but it may fail to germinate because it is dormant.

This condition of seed dormancy may be broken by carrying out a seed treatment exercise. The following are some of the seed dormancy breaking techniques:

Scarification: Scarification involves softening the seed coat of a seed by scratching or immersing it in hot water heated to a specified temperature for a given period of time. This makes the seed coat crack and expose the embryo to moisture and air for it to germinate. The seed can also be scratched by using sand paper to reduce the size of the seed coat which makes water and air easily reach the embryo. Sirato should be scarified before being sown by broadcasting.

Hulling: Hulling is the process of removing pods from around the seed. Hulling is commonly used in leguminous pastures such as silverleaf whose pods are firmly attached to the seed. In Malawi, farmers may remove the pods using a pounding mortar. Once the pounding has taken place, the pounded hulls are separated from the seed by winnowing.

Pelleting: This technique involves sticking of a thin layer of materials like lime, gypsum or rock phosphate around each seed. This method is carried out to enable seeds to germinate in soils with unfavourable soil pH or with nutrient deficiencies.

Inoculation: This method involves mixing a legume seed with a suitable type of rhizobium bacteria before sowing. Inoculation is done to ensure that there is successful nodulation and nitrogen fixation.

A farmer is expected to determine the seed rate of the seeds he is expected to sow. Seed rate simply refers to the amount of seed that is required per hectare. It can be calculated by using the following formulae:

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

Take note that seed size is the number of seeds per kilogram.

Practice problem

Calculate the seed rate for Torpedo grass given that the:

Seed size = 400 000 seeds per kilogram

Purity % = 90%

Expected plant population = 1, 000, 000 plants.

Working out

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

$$= \frac{1{,}000{,}000}{400\,000 \times 0.9 \times 0.6}$$

= 4.6 kgs per hectare

Factors that affect seed rate

There are some factors that affect seed rate. These factors include:

1. Seed size

Pastures with small seeds are sown at lower seed rates as opposed to those with large seeds. This is because a kilogram of small seeds contains a lot of seeds as compared to large seeds.

2. Germination percentage

Pastures with a high germination percentage will require less seeds as compared to those with low germination percentage.

3. Purity of the soil

A lot of seeds may be needed in soils which are mixed with plant residues as these may prevent some seeds from germinating as they may be blocked.

4. Nature of the stand

A pasture stand may be pure or mixed. In case of a mixed pasture stand the seed rate of each pasture is reduced in order to reduce competition between the two types of pastures grown.

5. Growth habit of the pasture

Those pastures with large vegetative growth need lower seed rates to minimise mutual shading.

6. Technique of sowing or planting

Some methods of sowing such as broadcasting require more seed than the drilling method.

7. Quality of the seedbed

The seed rate will be low in cases where the farmer has prepared her seedbed properly.

Fertilizer application at establishment

Pasture can get established easily when fertilizer is applied in correct amounts (table 8.1).

Table 8.1 Fertilizer recommendations for the establishment of direct planted pastures

Pasture type	**Type of fertilizer**		
	23:21:0 + 4S (Kg/ha)	CAN (Kg/ha)	Superphosphate (Kg/ha)
Pure grass ley or permanent pasture	200	-	100
Cut and carry grass	200	-	100
Grass/legume mixture	-	85	200
Leucaena	-	-	200
Pure stylo sward	-	-	200

Source: Ministry of Agriculture and Food Security (2012) *Guide to agricultural production and natural resource management in Malawi*. Lilongwe.

Weed control

A weed is any unwanted plant that is found in a piece of land. The weeds should be removed as soon as they appear in the pasture land. If weeds are left unchecked, they may result in reducing quality and yield of the pasture. They may also harbour some pests and diseases that can later on affect the pasture. The weeds may be removed by slashing, uprooting, hoeing or mowing. You can also control the weeds mechanically especially if they are planted in rows. One of the commonest weed in pastures is Wandering Jew (*Commelinabenghalensis*) which is locally known as*khovani*.

Fertilizer application

Appropriate fertilizers should be applied to pastures in correct amounts for maintenance (table 8.2).

Table 8.2 Fertilizer recommendations for the maintenance of established pastures

Pasture type	**Fertilizer type**			
	23:21:0 + 4S (Kg/ha)	CAN (Kg/ha)	Superphosphate (Kg/ha)	Potassium (Kg/ha)
Pure grass ley or permanent pasture	100	100 - 200	-	-
Cut and carry grass	100	100- 200	-	100
Grass/legume mixture	-	-	100	-
Leucaena	-	-	100	-
Pure stylo sward	-	-	100	-

Source: Ministry of Agriculture and Food Security (2012) *Guide to agricultural production and natural resource management in Malawi*. Lilongwe.

Pest and disease control

Pests should be controlled in the pasture land using appropriate insecticides (table 8.3).

Table 8.3 Examples of pests in pastures and how they can be controlled

Name of pest	**Control**
Army worms & elegant grasshopper	Spraying carbarly
Termites	Spraying dieldrin
Aphids	Spraying malathion

Take note that the pasture should not be grazed for at least 7 to 10 days after spraying chemicals. Diseases in pastures can be controlled by uprooting the attacked pasture plants and destroying them.

Methods of managing pasture

A farmer needs to be very careful when grazing her animals so that the animals give high yields while at the same time avoid overgrazing the pasture. The following are some of the pasture management methods:

a. Controlling stocking rate

Stocking rate refers to the number of animals that are allowed to graze on a unit area of pasture at a specific unit of time. The farmer is advised not to overstock or under stock the pasture land. Overstocking may lead to overgrazing which leaves the land bare making it susceptible to soil erosion. Under stocking the pasture means under utilizing the pasture.

b. Rotational grazing

Some farmers divide their pasture land into areas which are carefully fenced. These fenced areas are known as **paddocks**. Animals are allowed

to graze on pasture that is found on a given paddock at a specific time. After some days the animals are moved to the next paddock and the trend continuous like that. The already grazed pastures are left for a period of between 2 -4 weeks for the pasture to regenerate.

Activity 8.1

- *Be in pairs*
- *Brainstorm some of the general **advantages** and **disadvantages** of rotational grazing*
- *Report your answers to the rest of the class for comments.*

c. Strip grazing

Under this system the farmer divides the pasture land into strips made up of an electric fence. Then the animals are allowed to graze all the pasture found in the strip before they are moved to the next strip.

Advantages of strip grazing

1. It enables animals to completely feed on the pasture found in a strip.
2. It allows animals to have access to high quality pasture which is very fresh, digestible and with a high crude protein content.

Disadvantages of strip grazing

1. It may lead to soil erosion as the pasture is eaten completely from the small strip.

2. It is expensive to have a strip made of an electric fence.

d. Cut and carry

Cut and carry method is also known as zero grazing because animals are not allowed to move out of the stalls and graze. Instead the pasture is cut and fed to the animals while in their pens.

Activity 8.2

- *Be in groups.*
- *Brainstorm some of the **advantages** and **disadvantages** of zero grazing.*
- *Report your answers to the rest of the class for comments.*

e. Continuous grazing

This system of grazing is common in Malawi and mostly takes place on communal land. The system involves continuously grazing on the piece of land without giving it time to recover.

Advantages of continuous grazing

- It is cheap as no money is needed to manage the pasture
- It is less involving in moving animals from one paddock to another as in rotational grazing

Disadvantages of continuous grazing

- Pasture is not given time to recover leading to scarcity of pasture.
- It causes overgrazing.

- It enables parasites to complete their life cycles therefore affecting animal production.

f. Deferred grazing

This is a grazing system in which animals are allowed to graze on pasture during a specific season. In Malawi this system is common in dambos where animals graze only during the dry season.

The main advantage of this system is that the dambo becomes a very good source of pasture and water during the dry season. The problem with the system is that pasture loses its quality as it is grazed at the time when it has matured.

g. Burning pastures

Prescribed or controlled burning is done on natural pastures at the end of the growing season.

Activity 8.3

- *Be in groups.*
- *Brainstorm some of the **advantages** and **disadvantages** of burning pastures.*
- *Report your answers to the rest of the class for comments*

Methods of conserving pasture

There is plenty of pasture during the rainy season as compared to the dry season. As such, a farmer is supposed to find ways of ensuring that pasture

is made available to the animals in right quantities at all times. Some of the ways of conserving pasture are as follows:

1. Hay making

Hay making is the tradition way of conserving green crops and grass. Hay making is aimed at reducing the moisture content of the green crops and grass to low levels that enables satisfactory storage in stacks and bales for dry season feeding.

The farmer should consider the following during hay making:

a) The stage of growth of pasture at the time of cutting

This is the most important factor in determining the nutritive value of the conserved pasture. If the pasture is cut when mature, the farmer gets high yield. However, the digestibility, net energy value and voluntary intake of the dry matter is low.

b) Weather condition

The farmer should avoid cutting pasture for hay making during cloudy and humid weather. This type of weather affects proper drying or curing of the pasture as it develops moulds. The convenient time for hay making is at or near the end of the rainy season.

2. Straws and related by-products

Straws comprise of stems and plant leaves that are left after the removal of ripe seeds by threshing. Straws can be made from cereals such as maize stalks and from some legumes.

Once the straws are made they can be stacked and protected by thorn bush barriers. Then they can be fed to ruminant animals during the dry season. The nutritive value of the straws can be increased by adding a mixture of urea and molasses (1.5 -2.0% feed grade urea and 10% molasses).

3. Silage

Silage is made from the preservation of green forage under controlled fermentation. This process is called ensilage. The product is then stored in

a container known as a silo. Examples of crops that can be preserved as silage are grasses, legumes and whole cereals especially maize.

Silage is made by cutting and chopping the crop during harvesting. Then it is put in a silo and sealed. The silo is sealed in order to prevent entry and circulation of air during storage. A farmer can use plastic bags, pits, clamps or bunkers as silos.

Activity 8.4

- *Visit your library or internet room and research on the advantages and disadvantages of both silage and hay.*

You may have come across the following advantages and disadvantages of hay and silage. The following are the advantages of hay;

- It is a cheap source of livestock feed.
- It could be a source of income to the farmer if sold.
- It is a source of most nutrients required by ruminant animals when feed is scarce in the dry season.

The disadvantages of hay are;

- Some pasture species may not be preserved as hay because they tend to be too coarse, unpalatable and leaves shatter when dry.
- The pasture loses a lot of vitamin A during the drying process.
- Loses most of the proteins in the feed preserved.

Silage may have the following advantages;

- It preserves a lot of proteins and other nutrients.
- The feed continues to have its natural freshness (succulence).
- Most pasture varieties are preserved using this method.

The disadvantage of silage is that it might be expensive to preserve the feed as it requires a lot of labour and materials to make

4. Foggage

Foggage is pasture grass which is left ungrazed until the dry season. This makes the grass dry. As a result it is also known as standing hay. The composition of pasture species in the grassland determines the quality of foggage. If it's a mixed stand, that is comprising grass and legume, the quality of foggage is high because most legume species, when mature retain more nutrients than grasses.

The advantage of foggage:

- It supplies feed to livestock during the dry season when feed is scarce.
- It is a cheap way of preserving feed.

The disadvantage of foggage:

- There is a reduction of quality since the pasture matures. Grasses lose quality when mature.

Chapter summary

- *Pasture refers to the grass, legumes and other bushes that are used as feed for ruminant animals.*
- *Pasture is considered as the cheapest source of feed for ruminant animals.*

- *The two types of pasture are natural pasture and cultivated pasture.*
- *Broadcasting, drilling, oversowing, undersowing and vegetative propagation are some of the methods of sowing pasture.*
- *Pasture should be sown in time for easy establishment.*
- *Pasture can be managed by controlling stocking rate, rotational grazing, strip grazing, cut and carry, continuous grazing and deffered grazing.*
- *Hay making and silage are the two common methods of conserving pasture.*

End of chapter exercise

1. What is pasture?
2. Give any **four (4)** advantages of pasture.
3. Explain the difference between natural pasture and cultivated pasture.
4. Briefly describe how silage is made.

CHAPTER 9: AGRICULTURAL MARKETING AND TRADING

Introduction

Communities, districts and nations experience different climatic conditions. This makes these communities, districts and nations specialise in production of crops and animals that do best in those areas. When the people living in these areas want to use commodities they do not produce, they buy from other areas through trading. This means trading helps these communities, districts and nations obtain what they do not produce.

It is important to note that as commodities are being obtained from such areas they are produced to where they are not produced. They pass through certain channels and they are costs that are involved. The targeted person at the end of any marketing process is the consumer. The marketing process may be a success if demand for the commodities is high. Population distribution determines demand and this means it affects marketing.

This chapter describes trading of agricultural commodities, marketing channels, costs and margins and effects of population distribution on marketing.

Objectives

By the end of this chapter, you will be able to:

- *Distinguish between marketing and trading.*
- *List roles of marketing channels and agencies in marketing of agricultural commodities.*
- *Distinguish marketing costs and marketing margins.*
- *Describe effects of population distribution on marketing.*

- *Explain the importance of trading at community, national and international levels.*
- *Outline ways of improving trading of agricultural commodities.*

Definition of 'Marketing' and 'Trading'

Marketing is the performance of all activities involved in the flow of products and services from point of production to the ultimate consumer. This is a management process as it tries to find out what the consumer needs or wants and then supply such commodities efficiently and profitably. Marketing begins on the farm and ends with the consumer. **Trading** refers to the buying and selling of goods and services to make profits.

Marketing is related to trading as both involve transfer of ownership through buying and selling but marketing encompasses various activities including buying and selling. Other activities involved in marketing include: assembling, packaging, advertising, storage, transporting, processing, grading, market intelligence, financing and risk bearing. These activities take place from the time of harvesting farm produce to the time they are finally used by the consumers; hence these activities are called **marketing functions.**

Differences between marketing and trading

Table 9.1: differences between marketing and trading

Marketing	Trading
• It involves several marketing functions for the product to reach the final consumer. These functions include identification of consumer needs, grading, processing, transportation, displaying, financing, storage, risk bearing, buying and selling.	• It only involves buying and selling as marketing functions in the transfer of ownership.
• Uses farm inputs to produce crops and animals that consumers need at the time.	• Inputs are used for buying and selling goods at a profit.
• It takes consumers at heart by supplying what they want to satisfy them.	• It is solely concerned with sales
• It is flexible since it changes if consumer needs also change.	• It seeks to develop stronger sales strategy if consumer needs change.
• The selling function brings the attention and understanding of consumers.	• The selling function is the end point of trading
• The marketing channel under marketing may be wider since more agents are involved to grade, process, store, finance, buy and sell.	• It tends to have a shorter marketing channel as few marketing functions are practised.

Marketing channels and agencies of agricultural commodities

Marketing channels are routes that facilitate the transfer of ownership of a product from the point of production to the point of consumption. There are several stages between the point of production and the point of consumption. Marketing channels bridge the stages.

Types of marketing channels.

There are two main types of marketing channels and these are:

Direct marketing channel

The Direct marketing channel involves selling products directly to the consumer in order to allow the producer the possibility of receiving a higher price. This usually involves three critical steps:

1. Making a direct connection with consumers.
2. Determining the consumer wants or needs.
3. Offering products that meet those needs.

Direct Marketing may take many forms and usually includes a combination of techniques, such as selling to farmers markets, door-to-door sales, roadside stands, and direct sale to restaurants or institutions. Other special forms of direct marketing are discussed as below:

U-pick operations

Under this marketing channel, consumers come to the farm, do the harvesting, pay cash for the produce harvested and transport it home. It lowers the grower's costs of harvesting, sorting, packaging and marketing. The customer buys produce at peak freshness while enjoying a pleasant farm experience.

Community supported agriculture (CSA)

Community supported agriculture consists of a partnership between consumers and producers in which consumers contract or buy shares in farm products in advance and producers commit to supply a range of products over the entire season. Often, consumers have the option to participate in planting, cultivation and harvesting. The arrangement can be initiated by the producer or by a group of consumers.

Direct marketing channel can be illustrated in the figure 9.1 below.

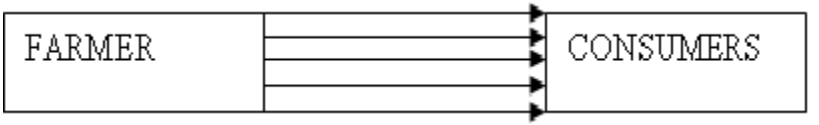

Figure 1.1: A direct marketing channel

Advantages of the direct marketing channel

There are a number of advantages of the direct marketing channel:

- Since small quantities of farm products can be sold, small producers can participate.
- The farmer sets the price or is in more control of the price. Good products and services can get attractive prices and therefore, small farms can be profitable.
- Payment is usually immediate.
- In addition, farmers receive instant feedback from customers on products and service. Therefore the farmer can improve her business through this input and increase farm profitability.
- It is a better way of marketing agricultural produce, especially of fruits and vegetables.

- It ensures direct contact of the producer farmers and the consumers and thereby enhances the distribution efficiency of the marketing system.
- It increases the profitability of agricultural crops for the producers by minimization of marketing costs and the margin of the middlemen.
- It ensures the availability of fresh fruits and vegetables and other farm produce at reasonable prices to the consumers.
- It removes social inhibitions among the farmers when sellling their produce
- It encourages additional employment for the producers and thereby enhancing their incomes.
- It provides and improves business techniques for the farmers so that in the long run they may adopt this practice for other crops and enterprises too.

Disadvantages of the direct marketing channel

- It is difficult to locate customers since they are many.
- There are low volumes of unit sales.
- The need for customers to be served and bad weather can discourage them from attending the market.

Indirect marketing channel

An indirect channel is a type of marketing channel which includes one or more marketing intermediaries performing a variety of functions. Each channel member provides value, performs a function and expects an economic return.

The length of the channel is determined by the number of intermediaries involved in the marketing of the product and also the length may determine the cost of the product. This means as the length of the marketing channel is widened, the cost of the product increases. This results in a high price of the product on the market. As we have already discussed, each intermediary provides value or performs a function to the product so that it fetches a higher price at the market. Figure 9.2 provides an illustration of various combinations of indirect marketing channels.

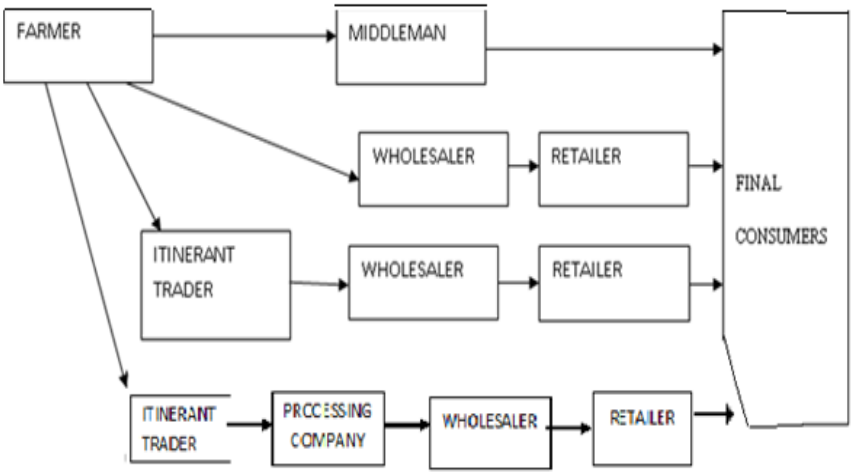

Figure 9.2: Examples of indirect marketing channel

An indirect marketing channel can be categorised basing on the number of intermediaries involved in the transfer of goods and services before they reach the final consumer. The categories of indirect marketing channels as shown in figure 9.2 are discussed as follows:

One-step marketing channel

This is the type of indirect marketing channel where the farmer sells the product to just one intermediary, who later sells it to the final consumer. It is called a one step marketing channel because the product passes through one middleman before the final consumer. This is also known as a **two-tier marketing channel** because the product reaches two people (middleman and the consumer).

Two-step marketing channel

The product is handled by two intermediaries before selling it to the final consumer. It is also known as a **three-tier marketing channel** since the product passes through a wholesaler, a retailer and a consumer from the farmer as shown in figure 9.2. Generally the wholesaler buys products from the producer and sells them to the retailer who later sells them to the consumer.

Three-step marketing channel

This channel is also known as a **four-tier marketing channel.** Under this channel, the itinerant trader buys from the farmer and then sells to the wholesaler. The wholesaler sells to the retailer and finally to the consumer. It is called a three-step channel because the product passes through an itinerant trader, a wholesaler and then a retailer before reaching the consumer.

Four-step marketing channel

The product is sold to the itinerant traders who in turn sell to a processing company. Wholesalers buy the products from these processing companies and then sell the products to the retailers. Because four agents handle the produce (itinerant trader, processing company, wholesaler and retailer)

before it reaches the consumer, that is why it is known as a four-step marketing channel. It is also called a **five-tier marketing channel**.

Benefits of indirect marketing channel

i. It is easy to reach more consumers because the length of the channel has been widened
ii. It is easy for the existing channel to link up with other producers.

Challenges of indirect marketing channel

i. Intermediaries may be unwilling or unable to sell the product.
ii. The intermediaries selling the product may be too costly.

Marketing agencies

Marketing agencies are individuals or organisations that carry out marketing functions. The agencies that are involved in marketing of agricultural produce are listed as follows:

a) Producer

The producer may sell what has been produced on the farm under the direct marketing channel. When the price of raw commodities at the market is not satisfactory, the producer may grade, store, process and transport the produce. Storage of farm produce is important since the farmer can sell the product when the commodity is scarce. By performing some marketing functions, the producer increases the value of the product.

b) Itinerant trader

Itinerant traders are individuals who buy farm produce from farmers by travelling to various parts of the community where farmers are found. They use their own means of transport to reach these farmers. Sometimes they exchange farm produce with salt, plastic plates, cups, baskets and buckets. When farm produce is bought or exchanged, an itinerant trader sells the products to wholesalers, retailers or final consumers. Apart from

buying farm commodities itinerant traders are also involved in bulking (assembling), transporting and financing the marketing process of farm produce.

c) Wholesalers

Wholesalers are agencies that buy farm produce in large quantities, grade, process and package them. When marketing conditions are not favourable, they may store the produce for some time and sell later. Generally wholesalers sell to other agencies such as retailers in bulk but at a low price. Many wholesalers specialise in particular products.

d) Retailers

Retailers are marketing agencies who specifically buy farm produce and resell directly to consumers. Retailers may be classified by:

- Type of produce sold i.e. cereals, legumes or vegetables
- Type of service offered i.e. self-service, counter service or selling through track containers (now common)
- Location of the retailer i.e. rural, city or sub-urban
-

e) Sales agents

Sale agents are marketing agencies who do not take title to the goods. The role of agents is to facilitate distribution by bringing buyers and sellers together. Sales agents often have close relations with particular growers, processors or manufacturers and contract to sell on their behalf in return for a commission. Some agents negotiate sales for a number of non-competing clients, whilst others handle sales for only one client and usually have the exclusive right to do so, within a specified geographic area.

f) Processing companies

Processors transform the agricultural products either partially or completely into the form to be consumed.

Activity 9.1

- *Name the processing companies found in Malawi.*
- *Mention the products processed by these companies.*
- *What are the end products produced after processing the agricultural produce.*

Discuss these questions in your study circles.

You may have discussed that they are a number of companies which are involved in the processing of agricultural produce which include the following:

- Grain and milling company (they process maize to ufa woyera and wheat to flour)
- Nali company (pepper to hot sauce)
- Dariboard Malawi limited(milk to yoghurt)
- Capital oil refining industry limited (sunflower and soya beans to cooking oil)
- Lever brothers limited (groundnuts to cooking oil)
- Agri-feeds (cereals and legumes to animal feeds)

g) Marketing companies

These are buyers who often carry out the initial task of assembling goods from dispersed farms or local rural markets. These buyers may be co-operative or government-buying agency. Sometimes they resell the produce when the commodity is scarce. Examples of marketing companies include Auction Holdings Limited, ADMARC, Alliance One and many more. These companies are also involved in selling of recommended seeds to plant, issuing licenses to producers and monitoring crop production.

Marketing costs and margins

Marketing Costs

By performing certain functions and services, various marketing organisations and agencies make it possible for commodities, produce and products to move from producers to consumers. However, these functions entail costs, often of considerable magnitude. The costs incurred by various marketing organisations and agencies as the produce moves from the farmer to the consumer is called **marketing costs.** In other words, marketing costs are payments along the marketing channel. Marketing costs vary from commodity to commodity and product to product. There are several factors that individually or collectively account for these differences. These include:

- The more waste the greater the proportion of customers' expenditure which goes on marketing costs.
- The more perishable the product the greater the marketing costs.
- The more processing of the commodity the greater the marketing costs.
- The greater the amount of produce handling and transportation the greater the marketing costs.

It is important that as the produce is moving along the marketing channel, costs should be as low as possible. The marketing system is said to be efficient if produce moves from the farmer to the consumer at a low cost.

Ways used to increase the market efficiency

- Increasing the volume of produce using improved handling methods
- Investing in modern technology
- Locating the product market in the most appropriate place
- Implementing better and appropriate farming practices in production
- Improving managerial planning and control of farm produce by making changes in marketing arrangements (e.g. by choosing the appropriate marketing criteria).

Sources of marketing costs

A source of marketing costs of agricultural produce is any activity that is done as the produce moves from the farmer to the consumer. As discussed earlier in this chapter, activities that are done along the marketing channel may improve the value of the produce as they involve costs. These activities may include: transport, grading, processing, packaging, storage, displaying, assembling and materials used in processing, grading, storage and displaying like sacks, pesticides and shelves. Depreciation, hiring of machinery, maintenance of machinery, utilities and taxes are also marketing costs though often overlooked. Profits and commission of agents involved in marketing are also regarded as marketing costs since they are charges paid along the marketing channel. *This means that the money paid and received by the marketing agencies constitutes the*

marketing costs. These are costs incurred by the itinerant trader, wholesaler, retailer, processing companies, sales agents and marketing companies and their profits and commissions.

Therefore, marketing costs can be calculated by considering the type of the marketing channel used in marketing the produce.

The **TOTAL MARKETING COSTS** will be **the sum of money paid by the marketing agencies** involved in the marketing channel. It will also encompass all the **money received by them in the form of profits and commissions.**

Marketing Margin

In the marketing of agricultural commodities, the difference between the price paid by consumer and the price received by the producer for an equivalent quantity of farm produce is often known as the **marketing margin**. This is also termed as **farm retail spread or price spread**.

The total margin includes:

- The **cost involved in moving the product from the point of production to the point of consumption**, i.e., the cost of performing the various marketing functions and of operating various agencies; and
- **Profits of the various market agencies** involved in moving the produce from the initial point of production till it reaches the ultimate consumer.

The absolute value of the marketing margin varies from channel to channel, market to market and time to time.

Example: Use the example Table 9.2.

Table 9.2

Let us calculate the marketing margin where the buying price from the farmer is K200 per kg, the weighted average wholesale selling price is K300 per kg and the weighted average retail price is K368 per kg.	
Marketing margin per unit kg will be:	
Wholesale margin = (300-200)	K100
Retail margin = (368-300)	K68
Total margin = (100+68)	**K168**

Using the same example, we can work out the contribution of each marketing agency for the product at the market. The contribution of each functionary is shown as a percentage. This is found by using the formula below:

% share of a functionary = $\frac{value\ of\ the\ produce\ at\ a\ channel\ level}{retail\ price} X100$

For example: the farmer sold the product at K200 and the product was sold at K300 at wholesale level. From example 9.1 the retail price was K368; the % share of the farmer will be: **(K200/K368) x 100 = 54.3%**

For the wholesaler: (K100/K368) x 100 =**27.2%** and at retail level it will be (K68/K368) x 100 which is **18.5%.**

Activity 9.2

With reference to example 9.1, it shows that the percentage share of the farmer is greater compared to the other marketing agencies; in this case the wholesaler and the retailer.

What could be the factors that contributed to the above situation? Discuss this in your study circles.

Difference between the marketing costs and marketing margin

Let us recall what was discussed earlier about marketing costs and margin. What are marketing costs and marketing margins?
You learnt that costs incurred by marketing firms or agencies are marketing costs and the difference between the price paid by the consumer and the price received by the producer for an equivalent quantity of farm produce is what is called marketing margin.

Using these definitions the difference between marketing costs and margins can be figured out. Therefore marketing costs are different from marketing margins in the sense that marketing costs are payments by the marketing firms or agents who are taking the farm produce to the consumer while marketing margins are payments by the consumer for the services to the marketing firms.

To make things simple let us use the marketing process to understand what is being discussed; the marketing process involves the transfer of ownership. As ownership is being transferred there is exchange of goods and services either for money or other goods and services.

In marketing of agricultural products marketing agencies take the raw produce or processed products to consumers. For marketing agencies to be able to reach consumers, they use their money to pay for the produce (at the farm level), cost of transport, labour, grading, storage,

processing and many other activities. On the other hand consumers pay money charged by the marketing agencies to have possession of the produce. In conclusion marketing costs are paid by marketing firms while marketing margins are paid by consumers.

However if total marketing costs are worked out; it will be noted that the value will be the same as the total marketing margin. This is because all these are payments along the marketing channel.

Population distribution in Malawi

Population distribution refers to the arrangement or spread of people living in a given area; and it is also referred to as, how the population of an area is arranged according to variables such as age, race, or sex.

Malawi occupies an area of 118,484 square kilometres, of which 94,726 square kilometres is land. It is divided into three administrative regions, namely North, Central and South and has four cities. The capital is Lilongwe which had an estimated population of 978,000 in 2014, while the largest city is Blantyre and had a population of 1.9 million in 2014 and is regarded as the commercial capital and Mzuzu had 130,000 people in the city). The 2008 Malawi Population and Housing Census enumerated the population to be 13.1 million, with an annual growth rate

of 2.8 percent and a density of 139 persons per square kilometre with an estimated 2014 population of 17.2 million.

The 2008 preliminary report of population and housing census indicates that Lilongwe has the highest population followed by Blantyre and Likoma has the least population in Malawi.

Table 9.2gives a summary of population distribution according to sex and districts.

Table 9.2: Preliminary report of 2008 population and housing census

REGION AND DISTRICT	**TOTAL**	**MALE**	**FEMALE**
Malawi	**13, 066,320**	**6,365,771**	**6,700,549**
Northern region	**1,698,502**	**824,057**	**874,445**
Chitipa	179,072	86,152	92,920
Karonga	272,789	131,882	140,907
Nkhata bay	213,779	104,541	109,238
Rumphi	169,112	83,051	86,061
Mzimba	724,873	349,150	375,723
Mzuzu city	128,432	64,341	64,091
Likoma	10,445	4,940	5,505
Central region	**5,491,034**	**2,695,950**	**2,795,084**
Kasungu	616,085	306,768	309,317
Nkhotakota	301,868	149,721	152,147
Ntchisi	224,098	109,349	114,749
Dowa	556,678	272,732	283,946
Salima	340,327	166,779	173,548
Lilongwe rural	1,220,146	599,955	628,191
Lilongwe city	669,021	339,030	329,991

Mchinji	456,558	227,373	229,185
Dedza	623,789	297,676	326,113
Ntcheu	474,464	226,567	247,897
Southern region	**5,876,784**	**2,845,764**	**3,031,020**
Mangochi	803,602	387,072	416,530
Machinga	488,996	234,747	254,249
Zomba rural	583,167	279,489	303,678
Zomba city	87,366	44,670	42,696
Chiradzulu	290,946	137,194	153,752
Blantyre rural	338,047	164,546	173,501
Blantyre city	661,444	337,655	323,789
Mwanza	94,476	45,672	48,804
Thyolo	587,455	279,979	307,476
Mulanje	525,129	247,391	278,038
Phalombe	313,227	149,471	163,756
Chikwawa	438,895	217,981	220,914
Nsanje	238,089	115,371	122,718
Balaka	316,748	151,637	165,111
Neno	108,897	52,889	56,008

Source: 2008 population and housing census preliminary report by national statistical office.

Effects of population distribution on marketing of agricultural produce

Activity 9.3

Visit a nearby market and observe the number of people who participated in the marketing process of various goods. Then ask some people selling agricultural products the following questions:

- *How does the number of people affect their business of the day?*
- *During which situations do they get a lot of money; when there are more people participating in the marketing process or when there are few people?*
- *Which time of the year do they enjoy their business and why?*

You will have noticed that the more the numbers of people present at the market and participating in various activities, the more vibrant the marketing process becomes. Therefore effects of population distribution on marketing are discussed as follows:

It dictates the direction of flow of farm produce

Large concentration of people entails a large number of consumers in an area. This means farm produce will be taken to areas with large populations since they offer attractive markets. In Malawi farm produce is collected from various parts of the country and taken into towns and cities because of a high concentration of people.

It determines the supply of farm produce required in an area

Highly populated areas require a lot of goods because demand is high for them. Therefore high supply of farm produce is needed in more highly populated areas than those with few people.

It affects the means of transport used to take farm produce to markets
In areas with small populations, farmers and other marketing agents take the farm produce using heads, wheelbarrows, bicycles and ox-carts to the markets because the loads are small and target small populations, but in areas with high populations like Lilongwe, Blantyre and Mangochi, cars can be used due to the bulkiness of the produce being transported.

It affects the length of the distribution channel
Farmers can reach consumers in places with low populations using direct marketing channels. Under this channel farmers may sell produce along roadsides and established markets by themselves since they serve few people. Wider marketing channels are used in areas with large populations.

It affects the form of products offered at the market
Large populations need a variety of goods to satisfy their needs. This means the products are handled to meet the satisfaction of consumers. Therefore marketing functions that aim at changing the form of produce like processing are performed.

It affects the demand of produce
Densely populated areas have greater demand for agricultural produce compared to sparsely populated areas.

Importance of trading

The importance of trading is recognised at community, national and international levels.

Importance of trading at community level

- The living standards of the community members improves due to income obtained from the sales.
- The community members are encouraged to engage in enterprises that will give them more profits since sales are done at a profit.
- It promotes members of the community to specialize in a particular enterprise they would find most rewarding.
- It helps members of the community to get rid of the surplus by selling it at a profit.
- Members of the community benefit from each other since they are able to sell their goods to one another.
- Trading helps to increase the productivity of the community since income obtained from the sales acts as an incentive to the members of the community to produce more.
- It promotes efficient division of labour in the community.

Importance of trading at national level

- It promotes efficient allocation of resources in the country in order to increase production.
- It helps the country to be economically stable due to increased production and creation of job opportunities.
- It unites people from various communities who meet to exchange various goods produced in different areas.
- It supplies local agro-industries with raw materials cheaply within the country.

- The nation can become specialised in some enterprises hence there is increase in output.
- It promotes the growth of factor markets.
- The urban population is also able to obtain food through trading.

Importance of trading at international level

- It helps countries to earn money from other countries (foreign currency).
- Trading helps countries to unite and have good relations.
- The country is able to get what it does not produce through trading.
- It gives consumers a wider choice of products being imported from other countries.
- Since more people from other countries access the products, markets are broadened thus encouraging farmers to use limited resources.
- Income obtained through export helps citizens buy things of their choice. This encourages them to increase production.
- It creates competition among farmers from various countries and this makes farmers work harder to improve methods of production so as to be able to maintain customers internationally.

Activity 9.4

What are the factors that can affect trading at community, national and international level? Discuss what could be done to make trading efficient at community, national and international level.

Trading can be affected by a number of problems. These problems include the following:

- Poor roads.
- Lack of farm inputs.
- High cost of production.
- Political differences and unrests.
- High taxes on goods being exported and imported.
- Poor market news.
- Currency instability.

Ways of improving trading of agricultural products

At community level

- making roads to markets accessible.
- promoting peace among members of the community.
- developing rural markets where communities can sell and buy goods.
- improving method of production to increase yield.

At national level

- promoting peace among people from various districts.
- constructing good road networks and other transport facilities like rail lines.
- adequate promotion of agricultural products to make consumers aware.
- making products relatively cheap by removing surtax.

At international level

- promoting good international relations.

- ensuring economic stability to prevent fluctuation of the exchange rate.
- promoting sales through trade fairs and internet marketing.
- producing quality products to meet consumer's needs.
- expanding volume of production.
- setting reasonable prices which are competitive.
- attracting nations to participate through reduction of any trade barrier.

Chapter summary

- *Marketing is the performance of all activities involved in the flow of products from producers to consumers.*
- *Trading means buying and selling of products at a profit.*
- *Marketing differs from trading mainly due to the number of marketing functions performed, satisfaction of customer needs, flexibility to changes in consumer needs and length of the marketing channel.*
- *Marketing relates to trading as both involve transfer of ownership of goods and services through buying and selling functions.*
- *The marketing process uses a path through which goods move to final consumers. The path is called a marketing channel.*
- *Marketing channels are categorised into two: direct and indirect channel.*
- *The Direct marketing channel involves selling products to customers directly and it involves the following critical steps: having direct connections to customers, determination of consumer needs and offering what they need.*

- *Direct marketing channels are achieved through door to door sales, roadside stands, on the farm sales and direct sales to restaurants or institutions.*
- *There are different forms of direct marketing channels which include: U-pick operations and community supported agriculture (CSA).*
- *The advantages of the direct marketing channel include small producers can participate, famers control the prices, payments are immediate and the profitability of the agricultural crops is increased.*
- *Disadvantages of the direct marketing channel include: difficult to locate customers, low volumes of unit sales and customers may be discouraged by bad weather.*
- *The indirect marketing channel uses middlemen to take the products to final consumers.*
- *The types of indirect marketing channels are one-step, two-step and three-steps marketing channels.*
- *The indirect marketing channel is beneficial since it is easy to reach consumers and existing channels can link up other producers easily.*
- *Marketing agencies are individuals or companies carrying out marketing functions.*
- *These marketing agencies include the producer, itinerant trader, wholesaler, retailer, sales agent, processing company and marketing companies.*
- *Marketing costs are costs paid by marketing firms as they are taking the products to the final consumer.*

- *The sources of marketing costs are transport, grading, sorting, maintenance, processing, displaying, hiring machinery and depreciation.*
- *Total marketing costs is the sum of money paid by the marketing agencies including the money received in the form of profits or commission.*
- *Marketing margin is the sum of money paid by consumers and it is also known as price spread or farm retail spread.*
- *Total marketing margin involves money paid to marketing firms for their services like grading, processing, assembling and displaying and their profits.*
- *Marketing costs are related to marketing margin as both are payments along the marketing channel. However they differ since marketing costs are payments by marketing firms or agencies while marketing margins are payments by consumers to marketing agencies.*
- *Population distribution refers to the spread of people in a given area.*
- *Population distribution affects marketing in the following ways; detects flow of produce, determines supply, affects length of distribution channel, determines form of products offered and demand at the market.*
- *Trading is important as it improves the living standards of people, provides employment, is a source of foreign currency, brings about economic stability of a nation and acts as an incentive to farmers hence production increases.*
- *Trading may be affected by poor roads, lack of farm inputs, political differences and unrest, high taxes, poor market news and currency instability.*

- *Trading can be improved by expanding volume of products, setting reasonable prices, making roads accessible and passable, promoting peace and improving methods of production.*

End of chapter exercise

1. Define the following terms:
a) Marketing
b) Trading
c) Price spread
2. Mention three differences between marketing and trading
3. State three reasons why trading is important at:
a) Community level
b) National level
c) International level
4. Explain briefly any two benefits of the direct marketing channel.
5. State any disadvantage of indirect marketing channel.
6. Distinguish marketing costs and marketing margin.
7. Mention any four sources of marketing costs.
8. Describe five effects of population distribution on marketing.

CHAPTER 10: REPRODUCTIVE SYSTEMS OF POULTRY AND CATTLE

Introduction

Poultry and cattle are some of the important livestock on the farm since they provide meat, eggs and milk. They are also important since they provide manure. Farmers desire to get maximum yield from their livestock. This can be possible if proper breeding is conducted. Breeding is a livestock management practice which helps animals to produce young ones. It is therefore necessary to understand the organs that are used in the breeding process for a successful breeding programme.

This chapter describes the anatomy and physiology of reproductive systems of poultry and cattle.

Success criteria

By the end of this chapter you must be able to:

- *Draw reproductive systems of cattle and poultry.*
- *Explain the functions of different parts of the reproductive systems of cattle and poultry.*
- *State the age at puberty for cattle.*
- *Describe the oestrous cycle for a cow.*
- *State the signs of heat in livestock.*
- *State the gestation period for a cow.*
- *Describe processes of reproduction in cattle.*
- *Describe the reproductive system in poultry.*

Reproductive organs of cattle

Activity 10.1

- *Be in groups of five*
- *Brainstorm some of the parts of a cow and a bull.*
- *Also brainstorm the functions of the parts of a cow and a bull.*
- *Record your answers and report to the class for comments.*

In your groups you may have discussed the reproductive parts of a bull and cow that are described below.

What should be borne in mind is that the reproductive organs of the bull are those that are directly involved in producing, storing, releasing, and delivering the sperms into the reproductive system of the cow for pregnancy to occur. The main reproductive organs of a bull are as follows:

- Epididymis
- Vas deferens
- Testes (testicles)
- Accessory glands (Cowper's gland, prostate gland, and seminal vesicles)
- Scrotum
- Urethra
- penis

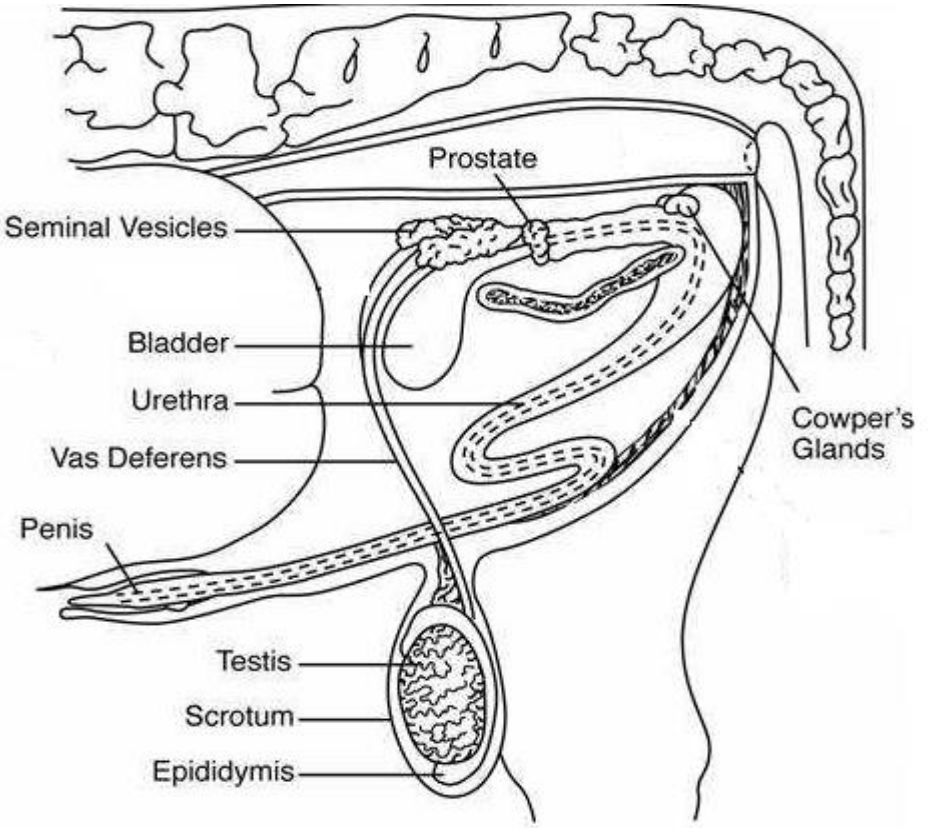

Figure 10.1: Reproductive system of a bull

FUNCTIONS OF REPRODUCTIVE ORGANS OF A BULL

Table 10.1 Reproductive organs of a bull and their functions

Part	**Description**	**Function (s)**
Penis	• It is a muscular and tubular structure which is located in a sheath outside the body of bull. • It has a head and a body with an opening at the tip known as urethra. • It comes out of the sheath when erect and gets back when relaxed.	• It is used for mating with the cow • It is used for depositing sperms or semen into the vagina during mating.
Testicles (testes)	• These are slightly firm, round or egg shaped male sex organs found inside a scrotum.	• They produce sperms • They also produce testosterone which is a male sex hormone

	• They loosely hang in the scrotum outside the body.	
Scrotum	• It is a sac with loose skin and muscle that hold the testicles. • It hangs between the hind (back) legs outside the body cavity of the bull.	• It supports and protects the testicles. • Controls the temperature of the testicles so that healthy sperms are produced. The temperature is kept slightly lower than that of the body.
Epididymis	• It is a long, narrow, tightly coiled tube through which sperms leave the testes for production. • It is closely attached to the backside of the testes within the scrotum.	• Site for maturing and storing of sperms. • It carries sperms to the sperm duct. • It provides a passage through which sperms can exit the testes. • It connects the testis with the sperm duct.
Sperm ducts (Vas	• These are long ducts or tubes,	• They carry sperms from the

deferentia)	one on each side of the testes. • They are an extension of the epididymis. • They are located between the epididymis and the urethra. • They join the urethra just below the bladder.	epididymis to the urethra during mating.
Urethra	• This is a tube from the urinary bladder and passing through the penis and delivers its contents outside.	• It carries urine from the urinary bladder through the penis to the outside. • It also transports sperms or semen to the outside through the penis during mating.
Accessory Glands (Cowper's gland, prostate gland, and seminal vesicles)	• These are a group of glandular tissues that produce fluids used within the reproductive system. **Cowper's glands:**	• Fluid from the Cowper's Gland help to clean urine out of the urethra. It also lubricates the urethra for the sperms to pass easily.

	They are small, firm glands situated on both sides of the urethra but below the prostate gland. **Prostate gland**: It is a gland situated at the neck of the urinary bladder and in front of the rectum. **Seminal vesicles**: They are a pair of glands situated behind the bladder near the prostate.	• The prostate gland produces a white or milky fluid that neutralizes acid in the urethra. The fluid also prevents urine from entering the urethra during ejaculation. • Seminal vesicles produce fluid which helps to transport the sperm. The fluid produced also provides the sperm with nutrients or energy to make it active. The largest volume of semen is made up of seminal fluid.

The reproductive organs of the cow are those that are directly involved in the production of an ovum, in the pregnancy of the cow, and in delivering the calf. The reproductive organs of the cow are around the pelvic region inside the cow. The major reproductive organs of a cow are:

- Ovaries
- Oviduct (Fallopian tube)
- Uterus (Womb)
- Cervix
- Vagina
- Vulva

The following diagram (figure 10.2) shows the reproductive organs of a cow.

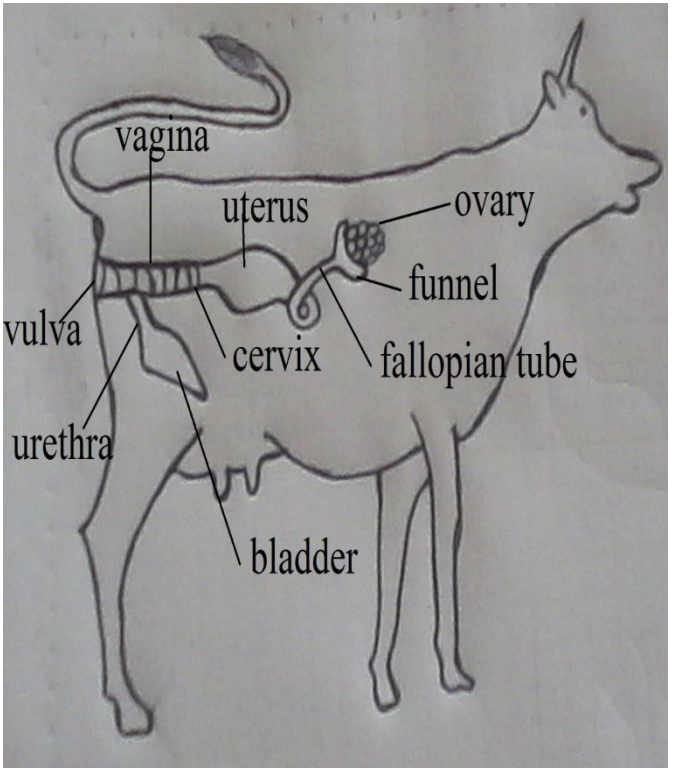

Fig. 10.2 Reproductive organs of a cow

FUNCTIONS OF REPRODUCTIVE ORGANS OF A COW

Table 10.2 Functions of the reproductive parts of a cow

Part	**Description**	**Function (s)**
Ovaries	• These are small, round, bean-shaped organs situated in the abdominal cavity of a cow. • They are found near the ends of the curved uterine horns. • They contain thousands of fluid-filled follicles (sacs) containing the developing egg cells.	• Produces eggs (Ova) • Produces hormones such as oestrogen and progesterone.
Oviducts (Fallopian tubes)	• These are a pair of thick-walled tubes or ducts that collect eggs from the ovaries and pass them to the uterus. • The openings of the oviducts are funnel-shaped	• They receive eggs from the ovaries and pass them through to the uterus. • They are a site for fertilization.

	and have finger-like projections that make egg collection easy.	
Uterus (Womb)	• It is a hollow organ with two horns connecting it to the oviduct. • It is situated between the oviducts and the cervix. • Its wall comprises muscular layers which help in pushing the calf during birth	• It is a site for the growth and development of the foetus until the calf is born. • Provides nutrients to the developing foetus.
Cervix	• It is the entrance to the uterus. • Made up of thick muscles.	• It works as a plug to protect the uterus from foreign material and infection entering from the vagina. • Acts as an entrance for semen during artificial insemination.
Vagina (Birth canal)	• It is a muscular canal or tube	• It receives semen from the bull

	located between the vulva and the cervix. • It is a site of mating between a bull and a cow.	during mating. • It serves as a birth canal for a calf during birth.
Vulva	• It is the outside part of the cow's reproductive system. • It lies below the anus of a cow. • It is made up of thick folds of skin.	• It is an entry for a bull's penis during mating. • It acts as an opening for the expulsion of a calf during birth.

PUBERTY IN CATTLE

Puberty is the age of sexual maturity in animals. This age is characterized by production and release of sperms and eggs in male and female animals respectively. In a well-managed flock, bulls and cows reach sexual maturity when they are eight and nine months old respectively. Puberty is hormonal dependent which means it depends on hormones. The male hormone secreted to facilitate production and release of sperms is testosterone. This hormone also controls maturity of reproductive organs and sexual desire. The hormone estrogen in cows ensures maturity of the reproductive tract, egg development and ovulation.

Factors influencing puberty

Different animals reach the puberty stage differently and this is due to a number of factors. These factors include;

Breed of animal: Exotic breeds reach the puberty stage faster than indigenous breeds. Smaller breeds of cattle reach puberty earlier than bigger ones. Dairy cattle breeds reach puberty earlier than beef cattle breeds.

Age: Cattle reach puberty at a particular age. This happens when they are between 8 – 15 months of age.

Weight: An underfed heifer with a lower weight will reach puberty later than one which is wel-fed and has a higher weight. Puberty in heifers will occur when they have gained about 65% of their mature body weight.

Feeding: Animals that are well-fed reach puberty faster than those that are poorly fed.

Climaticcondition: Higher or warmer temperatures hasten the time for the cow to reach puberty.

Exposure to animals of the opposite sex:Those heifers that are mixed together with bulls tend to reach puberty faster than those kept away from bulls.

Activity 10.2

Visit the nearest cattle farmer and find out the following:

- *The age at which their cattle reach puberty.*
- *The weight at which their cattle reach puberty.*
- *How they are able to determine when the cattle have reached puberty.*

Discuss your finding with your classmates.

The process of reproduction in cattle

Reproduction in cattle is the process in which calves are produced. Cattle reproduce sexually where a bull and a cow are involved.

The process of reproduction in cattle can be described as below:

- Firstly, the bull and the cow must be in good health and sexually mature.
- Then a bull should mate with a cow on heat.
- The sperm and the ovum unite in the oviduct and form a zygote.
- The zygote moves to the uterus.
- The zygote attaches itself to the wall of the uterus where it further grows into a foetus.

- After about 9 months, the cow gives birth to the calf.

Oestrous cycle in cows

The oestrous cycle refers to the changes that occur in female animals from one heat period to another. It happens after the female has reached puberty. This cycle is controlled by hormones. It mostly starts with the heat period and stops as soon as the cow is pregnant.

The oestrous cycle of the cow is generally about 21 days long, but it can range from 17 to 24 days. Each cycle consists of a long luteal phase (days 1-17) thus anestrous phase where the cycle is under the influence of progesterone and a shorter follicular phase (days 18-21) where the cycle is under the influence of oestrogen. The cycle begins with standing heat, or oestrous. This time of peak oestrogen secretion can last from 6 to 24 hours, with ovulation occurring 24 to 32 hours after the beginning of oestrous.

Figure 10.3gives a summary of the signs of heat at each respective stage of the oestrous cycle.

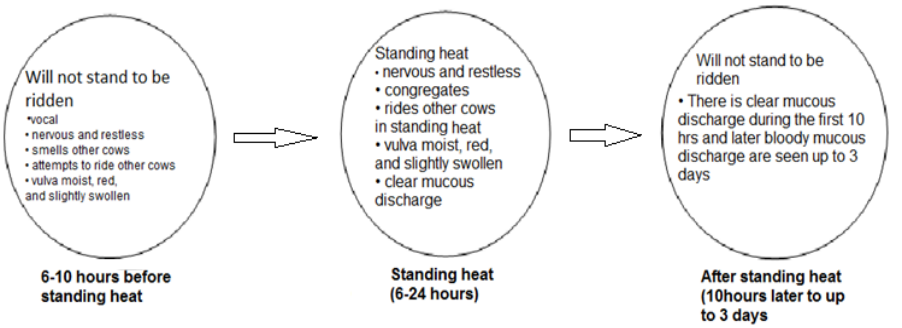

Fig. 10.3: Signs to look for before, during and after the heat period (oestrous cycle).

The oestrus cycle has four phases and they are described as follows;

Proestrus

One or several follicles of the ovary start to grow. Their number is species specific. Typically this phase can last as little as one day or as long as three weeks, depending on the species. In cows it takes 1-3 days. Under the influence of oestrogen the lining in the uterus (endometrium) starts to develop. Some animals may experience vaginal secretions that could be bloody. The female is not yet sexually receptive but the old corpus luteum gets degenerated. The uterus and the vagina get distended and filled with fluid, become contractile and secrete a fluid.

Oestrous

Oestrous refers to the phase when the female is sexually receptive ("on heat"). This takes 24 to 32 hours from the onset of the heat period which is day 18-21. Under regulation by gonadotropic hormones, ovarian follicles mature and estrogen secretions exert their biggest influence. The female then exhibits sexually receptive behavior, a situation that may be signaled by visible physiologic changes. It is thought that this increased sexual receptivity is a functional design in order for the female to obtain mates with superior genetic quality.

Metoestrous

This phase is characterized by the activity of the corpus luteum, which produces progesterone. The sign of oestrogen stimulation decreases and the corpus luteum starts to form.

Dioestrous

The corpus luteum is retained as a result of fertilization and pregnancy begins. If fertilization did not take place the corpus luteum degenerates.

The oestrous cycle differs with the type of animal. Different animals have different length of the oestrous cycle. The variations are as follows;

- Ewe (sheep) : 17 days
- Cow (cattle) : 21 days
- Sow (pig) : 21 days
- Doe (goat) : 21 days

Signs of heat

- **Congregating.** Cattle that are on heat naturally seek out other animals on heat and form a small group, referred to as the sexually active group. They make physical contact with each other, standing head to tail, circling, butting heads, and resting their chins on the back or hip of other cows.
- **Mounting other animals.** A cow on heat mounts other cows.
- **Clear mucus from vagina.** Estrogen causes thick, clear mucus to be released from within the cow's cervix. Strings of mucus hanging from the vulva or smeared on the tail and buttocks are a good sign that the cow is on heat.
- **Nervousness or restlessness.** This may be excessive walking and bawling. Watch for any animal that is moving when other animals are relatively stationary. She might be walking a fence line in search of a bull.
- **Swollen vulva.** A moist, red, and swollen vulva is often associated with heat period.
- **Loss in appetite.** Less food is eaten since the animal is restless.
- **Frequent urination.**
- **The cow sniffs the vulva of other cows**.

- **Less milk produced**. This is because the animal takes less food.

Ovulation
Ovulation is a process in which a developed ovum (egg) is released from the ovary. Ovulation in cow takes place about 4 – 16 hours after the start of the heat period. It is controlled by hormones in the cow. Once an egg is released from the ovary, it travels through the oviduct to the uterus.

Fertilization
Farmers should utilize the onset of the heat period in farm animals since it's the period where animals mate. If successful mating is done the animals are said to be served. In other words, fertilization taken place.

Fertilization is when the ovum unites with the male gamete (sperm) to form a **zygote**. This takes place in the fallopian tube (oviduct). Soon after fertilization, the zygote is implanted in the uterus where continuous cell division occurs. Through continuous cell division the zygote continues to grow and it is then called the embryo and later a foetus. While in the uterus, the embryo is surrounded by membranes which are formed and attach the embryo to the uterine lining.

After the embryo has fully been implanted in the uterus a very important organ called a **placenta** develops and it nourishes the growing young, transferring nutrients and wastes between the cow and the foetus.

Gestation period
The period of pregnancy in a cow is known as the**gestation period**. The period of pregnancy varies with the different types of animal. Table 10.3 gives some examples of the length of the gestation period for different animals.

Table 10.3: Length of gestation period for some livestocks

Animal	Length of gestation in days
Cow	278-285
Sow	114-115
Ewe	150
Goat	153
Rabbit	28-30

From table 10.3, it is observed that the cows' gestation period takes about 278 to 285 days (approximately 9 months) and the birth of the young occur by muscle contractions in the uterus.

Caring for cows during pregnancy

A pregnant cow needs to be given nutritious foods so as to support its own body and that of the developing foetus. The growth of the foetus is slow during the first 6 months of pregnancy as such; there is no high demand for additional nutrients for the foetus. Good fresh grass can support the nutrient demand for both the cow and the foetus.

Growth of the foetus picks up after 6 months and this increases demand for more nutrients from the mother. Food rich in minerals such as calcium and phosphorus and more proteins are needed. The minerals are important for bone formation and the proteins for growth. Supplementary feeds such as silage, legumes, salt and mineral licks should be made available to the cow.

Clean drinking water should be provided to the pregnant cow at all times.

Parasites and diseases should be controlled to enable the cow to stay healthy. A suitable house should be provided for the cow if possible.

A few days before calving, the following should be done:

- Reduce the amount of concentrate feed to cows especially those with a record of having difficulties in calving. This is to prevent the cow becoming fat which brings problems during calving.
- Provide the cow with wet maize bran which prevents constipation during calving.
- Isolate the pregnant cows from the herd so that enough attention is provided to them.
- Closely observe the pregnant cow for any signs of calving. Pay attention to the cow as soon as it starts calving so that assistance may be rendered to the cow.

Parturition

Parturition is the process of giving birth to a calf. It is also called **calving**. Parturition marks the end of the gestation period. During calving a placenta (after-birth) is expelled by the cow.

Signs of parturition in cows

The farmer is expected to take note of the following signs of parturition:

- The teats and udder become large, tight and swollen.
- Some milk may leak from the teats.
- The vulva becomes swollen, large, and releases some mucus.
- The cow moves around, lies down, and gets up more often.
- The cow stops eating because of restlessness and discomfort.
- The cow tends to be in isolation.
- The cow urinates frequently.
- The amniotic sac breaks, releasing the amniotic fluid when the cow starts giving birth.

Dystokia

Sometimes a cow may have difficulties in giving birth. This is referred to as **dytokia**. The cow cannot manage to deliver the calf on its own but requires some help. When help is not provided in good time both the calf

and the cow may die, be injured or disabled. The good thing is that dystokia is not common amongst cows.

Causes of dystokia

Dystokia is caused by the following:

- Bad positioning of the foetus before birth. The foetus could be lying on its back in the uterus, with its head bent backwards, having its front legs bent backwards; or facing backwards. These positions will make calving difficult.
- Oversize foetus. When the foetus is bigger than normal, it will not easily come out even if the cow applies a lot of force to it.
- Size of the cow. A cow with a small body build and small pelvic area will experience difficulties giving birth. Such animals should not be mated with a bull from a breed with a big body build because the calf to be delivered is also expected to be big.
- Inability of the uterus to contract enough or sufficiently. Insufficient contraction of the uterus during calving means difficulties in expelling the calf.
- Failure by the cow to push the calf due to it being weak.
- Reduction in the size of the birth canal due to too much fat accumulating around the pelvic area.

Control of dystokia

- All cows with narrow or small pelvic area should be culled.
- Remove from the herd all cows that had problems in calving.
- Provide a balanced ration to all cows during pregnancy to prevent them getting too fat or too thin.
- Closely monitor cows when giving birth so as to provide help if necessary.

Reproductive system in poultry

Poultry are domesticated birds. Examples include chickens, ducks, doves and turkeys among others. Chickens are the most kept domesticated birds in Malawi. A male chicken is known as a cock and a female is called a hen.

Reproductive organs of a cock

A cock has a pair of testicles that are situated high up in the abdominal cavity. Each testis joins itself to the vent (cloaca) through a sperm duct. The sperm duct is also known as the vas deferens. Figure 10.3 shows the reproductive parts of a cock.

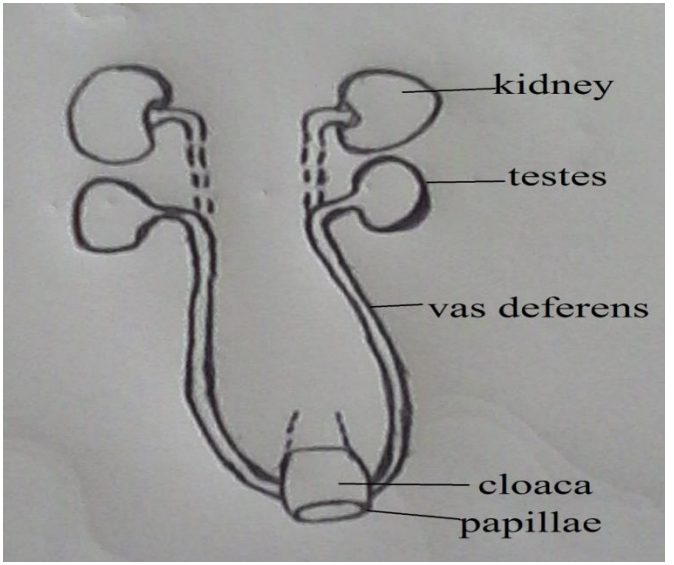

Fig. 10.3 Reproductive organs of a cock

Reproductive organs of a hen

The reproductive system of a hen is different from that of other female animals. It comprises only one well developed and functional ovary. This well-developed ovary is situated on the left hand side of the hen. A section of an oviduct of a hen (fig. 10.4) has its parts arranged as follows:

- Infundibulum
- Magnum
- Isthmus
- Shell gland (uterus)
- Vagina
- Cloaca (vent)

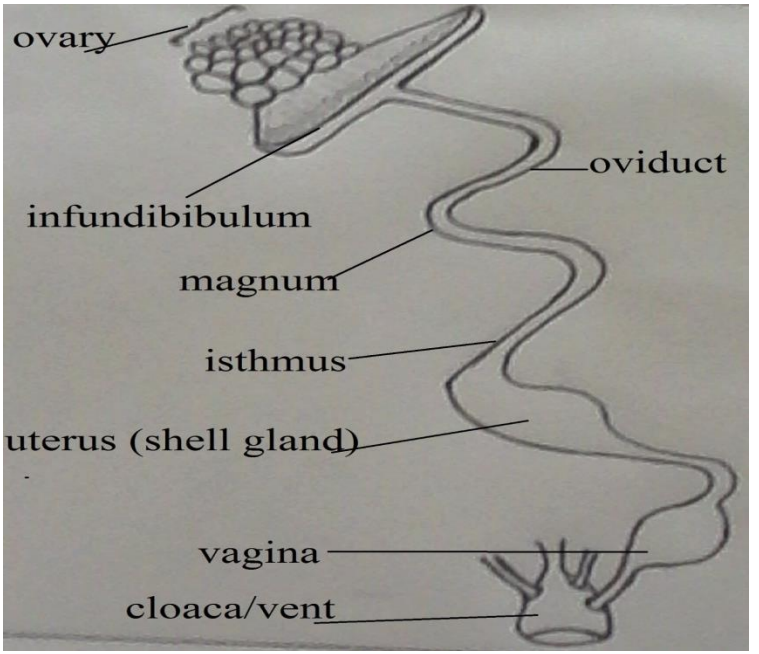

Fig. 10.4: The reproductive system of a hen

Table 10.3 Functions of the reproductive parts of a hen

Part	**Functions**
Infundibulum (funnel)	• Site for fertilization • Receives eggs from the ovary • Receives and stores sperms after mating
Magnum	• Site for albumen production and addition to the egg
Isthmus	• Shell membrane production and addition to the egg
Uterus	• Shell is added to the egg
Vagina	• Sealing of pores in the egg
Cloaca (vent)	• Exit for an egg

End of chapter summary

- *The reproductive organs of a cow are ovaries, oviduct, uterus, cervix, vagina and vulva.*
- *The penis, testes, scrotum, epididymis, and sperm ducts are reproductive organs of a bull.*
- *Puberty is the stage at which an animal becomes sexually mature.*
- *Onset of puberty is influenced by breed, age, weight, climate and feed.*
- *The process in which young ones are produced is known as reproduction.*

- *Oestrous cycle refers to the changes that take place in the body of an animal from one heat period to the other.*
- *A cow on heat becomes restless, stands still when mounted, urinates more often, and has a habit of sniffing the vulva of other cows.*
- *The release of an egg from the ovary is known as ovulation.*
- *Fertilization refers to the union of male and female gametes.*
- *Gestation period is the length of time between fertilization of an egg and birth.*

End of chapter Exercise

1. Name the organ that supplies a developing foetus with nutrients.
2. State **two** functions of the Cowper's gland.
3. a) Describe how a calf could be positioned during normal birth.
   b) Describe the positioning of calves in the womb that can result in dystokia.
4. Describe how cows should be taken care of during pregnancy.
5. Suggest **four** measures that can be taken to control dystokia.

CHAPTER 11: LIVESTOCK IMPROVEMENT

INTRODUCTION

There is an increase in demand for animal products like meat, milk and eggs. This is due to the increase in human population and reduced yield from the livestock. Malawi has put in place measures to control population growth so that it matches with the available resources. There are also efforts to improve yield of livestock through proper management practices like proper feeding, housing, breeding and parasites and disease control. Livestock give high yields, not because of general management practices alone, genetic makeup of the animal also is a factor as it affects the extent of the response of animals to these management practices.

It is therefore important to improve the livestock's genetic makeup to compliment the farmers' efforts in improving the yield of livestock by proper management. This chapter looks at methods of livestock improvement so that yield is maximized.

Objectives

By the end of this chapter, you will be able to:

- *Define the term livestock improvement.*
- *State the aims of livestock improvement.*
- *Describe the methods of livestock improvement.*
- *Identify characteristics of livestock to be selected for breeding.*
- *Describe livestock breeding systems.*

Meaning of livestock improvement

Activity 11.1: Research

- *Ask students to research on the meaning of the term livestock improvement in the library.*
- *Ask them to report what they gathered from their research.*

From the research it can be noted that livestock improvement is an act of improving the hereditary material in animals in order to increase the animals' yield. Hereditary materials are known as genes. Genes are contained in the nucleus of the cells. During the time animals are mating, the male gamete (sperm cells) carry genes; likewise the ova has the genes. It is known that during fertilization both the male and the female sex cells contribute an equal number of genes.

In livestock improvement, desirable genes can be maintained and fixed or farmers can change or modify the arrangement of genes completely by bringing in good genes extracted from other animals' sex cells.

Aims of livestock improvement

Some of the aims of livestock that you may have discussed are as follows;

- To increase the growth rate of the livestock so that the animals are able to reach maturity stage fast.
- To increase the quality of livestock products i.e. meat, milk and eggs.

- To enhance the reproductive potential of the livestock. That is to enhance the capacity of the animal to produce more yields.
- To increase livestock resistance to diseases and parasites.
- To increase the livestock's resistance to local climatic conditions.

Methods of livestock improvement

There are three main methods of livestock improvement and these include;

- Selection
- Mating systems
- Introduction

Selection

Selection is the method of livestock improvement which allows certain animals to be parents of future generations. The animals which have desirable characteristics are used as breeding stock. Selection is based on the assumption that these desirable traits are passed on to young ones. The physical appearance of the animals selected has a direct link with good traits farmers look for when selecting animals under this method. This means farmers use the phenotype of the animals (the physical appearances).

These traits have genetic component which are known as genotypic traits but are also influenced by environmental factors. In simple terms it can be stated that the phenotypic traits which are the main indicators as far as the selection method is concerned are as a result of genetic make-up of the animal as well as the environmental factors.

The larger the genetic component of a trait, the higher the chance that desirable characteristics will be passed on from parent to offspring. When a male animal is selected by a farmer because it has a good physical appearance and produces young ones of desirable physical characteristics is called ***progeny testing***. Female animals selected for their good phenotypic traits like milk production and egg production are called ***sib selection.*** Farmers use the livestock selected to act as parents for the next generation with an assumption that the good traits observed will be passed on to the young ones. The major benefit of this method is that it increases the occurrence of the desirable genes and suppresses the undesirable genes. However it does not introduce any new gene if desirable genes are lacking in the animals.

Forms of selection

Principles of livestock improvement form the basis of different types of selection. These may operate within individual herds, among a group of cooperating farmers aiming to achieve a similar objective, or nationally. Some of the important forms are described as follows:

a. Artificial selection

The artificial selection method is based on the principle that in each herd there is a small number of genetically very superior animals which if brought together will form a basis whose average genetic value is far greater than herds from various farmers who brought them. The important element in this method is therefore for a group of farmers to agree to pool their high performing animals. Once the desired herd is assembled, an efficient system of recording and selection is implemented. The best males are kept for breeding in the group. This method is known as artificial selection since the farmers are the ones doing the job of selecting the animals.

The main advantage in artificial selection is that desirable characteristics may be fixed in the animals since these cooperating farmers will base their selection on their main objective. It is particularly attractive in situations where within-herd selection programmes are ineffective due to small population size or inadequate technical skill.

b. Natural selection

Animals from different herds are assembled in testing stations and measured under a uniform environment where the farmers can use this method either for performance testing, e.g. growth rate, or for progeny testing, e.g. milk yield. It is believed that some animas are better favoured than others hence their performance tends to differ though the animals are exposed to the same environment. The animals that will be able to cope with the environment are selected,

Characteristics of livestock farmers look for during selection

You may have discussed some of the characteristics of the livestock as follows;

- Good temperament.
- High milk yield.
- Fast growth rate.
- Good mothering ability.
- Good brooding habit.
- Ability to work (for draught animals).
- High meat quantity and quality.
- Resistance to parasites and diseases.

Mating systems

Mating systems is the method of livestock improvement which brings the desirable characteristics together through mating of animals of superior traits. It is believed that those traits will be passed on to the young ones.

There are two main methods used and these are discussed as follows;

1. **Inbreeding**

Inbreeding is the breeding method where closely related bloodlines are mated to supply straight bred animals with high performance. This method increases the number of pairs of homozygous genes for a characteristic thereby purifying the desirable characteristics. The major advantage of this method is that the animals tend to be uniform since the same type of genes are transferred to young ones. If this method is repeatedly done, genes are fixed and a pure breed is produced. A pure breed is the offspring resulting from repeated inbreeding. If inbreeding is done repeatedly, the offspring tend to have a lot of similar genes (homozygous genes) in their cells. As a result pure breeds look similar or are uniform in appearance. This happens when the parental lines are bred for about 5-6 years repeatedly.

2. **Cross breeding**

Cross breeding is the method of livestock improvement which brings new genes in the offspring. This is a system that mates unrelated animals. It is also known as out- breeding or out-crossing. Because the animals are from animals that are not related, they pass on different but desirable genes to the offsprings. Outbreeding can be exploited to obtain **hybrid vigour**. For example, in some characteristics like growth rate, if parents are mated, the young ones will grow faster than either of the parents. This superiority in growth rate displayed by a crossbred progeny is what is known as **hybrid vigour or heterosis.**

3. Introduction

Introduction is the artificial introduction of bringing exotic, pure-bred animals with desirable characteristics into one's country.

An example of introduction is the bringing in of dairy breeds like Friesian and Jersey into Malawi from Europe and America for milk production. It is important to consider the climatic conditions of the country from which the animals originate. The climatic conditions should match. It is also important to take care of the animals once introduced. This is to say, proper management practices should be followed.

Another important aspect is to put the animals under quarantine to observe the animals closely so that the farmer should know if the animals have some diseases.

There are two main ways of how the introduction method is done. Firstly exotic bulls of superior characteristics are imported into one's country and the farmers use them to mate with the indigenous cows. Another way is through artificial insemination.

Artificial insemination

Artificial insemination is the technique in which semen with living sperms is collected from the male and introduced into the female reproductive tract, at a proper time, with the help of instruments. This has been found to result in normal offspring. In this process, the semen is inseminated into the female by placing a portion of it either in a collected or diluted form into the cervix or uterus by mechanical methods at the proper time and under the most hygienic conditions.

Semen collection method

The commonly used semen collection method is through use of an artificial vagina. The parts of the artificial vagina are described bellow:

It is turned through the threaded nut up or down. The water jacket of the Artificial -vagina is filled with hot water at a temperature of 45°C by opening the nozzle. The graduated semen collection tube is fixed to the narrow end of the artificial vagina tube, and fastened by a rubber band. The inner side of the rubber liner on the anterior side of the artificial vagina is lubricated with sterile jelly to a length of 7 to 10 cm. Air is blown through the nozzle into the water jacket, to create pressure to simulate the natural vagina.

The temperature of the artificial vagina is to be checked, at each collection, and it should resemble the natural vagina at mounting time. If it is too cold, ejaculation may not be there after a push, or even if ejaculation is there; it may be contaminated with urine, and becomes unfit for use.

Semen collection procedure

The cow or dummy is secured in service. The artificial vagina assembled is held at a 45° angle from the direction of the penis, and the insertion is at that angle. The artificial vagina is held with the left hand by a right handed person; and when the bull mounts the cow, the cover of the bull will be graphed by the operator, directing the gland penis into the artificial vagina, and then the bull gives a push to ejaculate. Figure 11.1 demonstrates how semen is collected.

Figure 11.1: False mounting

The operator should demonstrate care so as not to touch the exposed part of the penis. After the bull dismounts, the artificial vagina is taken off from the penis and the air vent is opened to release the pressure from the jacket.

The water from the jacket is also removed by opening the nozzle. This allows the ejaculated fluid to flow from the cone to the semen collection tube. The semen collection tube is detached from the cone, plugged with cotton wool, and taken to the laboratory for examination. The rubber cone and the semen collection tube can be protected from external contamination or heat, by covering it with an insulation bag with a zip.

Figure 11.2 shows an artificial vagina.

Figure 11.2: an artificial vagina

Semen storage

Bull semen could be successfully frozen and stored for indefinite periods. Scientists discovered that the addition of glycerol to the semen extender improved resistance of sperm to freezing. Glycerol acts to remove water from the sperm cell prior to freezing and prevents the formation of cellular ice crystals which would damage the sperm. There are two methods of freezing and storing semen: dry ice and alcohol (-73 degrees Celsius) and liquid nitrogen (-195 degrees Celsius). Liquid nitrogen is preferred because there is no evidence of fertility deterioration with time. Fertility gradually declines in semen stored in dry ice-alcohol.

Frozen semen can be stored **for a longer period of time** if proper temperature is maintained. Fresh, liquid semen can be successfully stored for 1 to 4 days at 4.4 degrees Celsius. Semen is usually stored in glass containers. Artificial coloring is frequently added to semen extenders in order to distinguish one breed from another. Complete identification of the bull is required for each individual semen container.

Advantages of Artificial Insemination

- There is no need of maintenance of breeding a bull for a herd; hence the cost of maintenance of breeding a bull is saved.
- It prevents the spread of certain diseases and sterility due to genital diseases. E.g.: contagious abortion, vibriosis.
- Regular examination of semen after collection and frequent checking on fertility, make early detection of inferior males possible and better breeding efficiency is ensured.
- The progeny testing can be done at an early age.
- The semen of a desired size can be used even after the death of that particular bull.
- The semen collected can be taken to other countries for insemination.
- It makes possible the mating of animals with great differences in size (i.e. heavy bulls to small cows) without injury to either of the animal.
- It is helpful to inseminate the animals that refuse to stand or accept the male at the time of Oestrous.
- It helps in maintaining accurate breeding and calving records.
- It increases the rate of conception.
- It helps in better record keeping.
- Old, heavy and injured sires can be used.

Disadvantages of Artificial Insemination

- Requires well-trained operations and special equipment.
- Requires more time than natural services.

- Requires wide knowledge of the structure and function of reproduction on the part of the operator.
- Improper cleaning of instruments and un-hygienic conditions may lead to lower fertility.
- If the bull is not properly tested, the spreading of genital diseases will be increased.
- Market for inferior bulls will be reduced, while that for superior bulls is increased.

SUMMARY

- *Livestock improvement is the art of improving the hereditary material in livestock in order to increase yield.*
- *There are three main methods of livestock improvement namely selection, mating systems and introduction.*
- *Selection is a method that dwells much on choice of parents with desirable phenotypic traits for breeding. This method is grouped into natural selection and artificial selection. The characteristics considered include milk yield, growth rate, disease resistance and high quantity and quality of yield.*
- *Mating system is a method that allows animals of desirable characteristics to mate and it is categorized as inbreeding and cross-breeding.*
- *Inbreeding is when animals that are related are mated whereas cross-breeding mates animals that are not closely related.*
- *Introduction is the method of livestock improvement which allows farmers to import animals of desirable characteristics into another country e.g. from America to Malawi.*
- *Artificial insemination is a form of introduction.*

End of chapter exercise

1. Give any two methods of livestock improvement.
2. Describe any one effect of the following mating systems.
    a. Inbreeding
    b. Cross-breeding
3. Describe any three advantages of artificial insemination.
4. Differentiate progeny testing and sib selection**.**

CHAPTER 12: DAIRY AND BEEF PRODUCTION

Introduction

Dairy cattle are animals which are bred for milk production and beef cattle are those bred for meat production. Dairy and beef production is important in Malawi for improved human nutrition and increased income among other reasons. The overall milk and beef production is generally low because of low genetic potential and poor management of such things as housing, nutrition, disease control and breeding.

This chapter seeks to describe the breeds of dairy and beef cattle and practices that aim at improving beef and milk production.

Objectives

By the end of this chapter, you will be able to:

- *List names of cattle for dairy and beef production.*
- *Describe characteristics of cattle breeds for dairy and beef production.*
- *Describe management practices for beef and dairy production.*
- *Identify a suitable house for cattle.*
- *Describe how to construct an appropriate house for cattle.*
- *Identify suitable feeds for cattle.*
- *Identify parasites and diseases of cattle.*
- *Explain how to control parasites and diseases.*

Breeds of dairy and beef cattle

In Malawi, farmers raise several breeds of dairy and beef cattle. The most predominant breed is the indigenous or local breed. Other farmers keep exotic breeds of beef and dairy cattle. This means that Malawian farmers raise two types of dairy and beef cattle namely **local and exotic breeds.**

The commonly raised local breed of beef and dairy cattle is Malawi Zebu. Malawi zebu is known by low meat and milk production but crosses between the Malawi Zebu and exotic beef or dairy cattle are superior to unselected and selected Malawi Zebu in terms of birth weight, weaning weight, daily weight gain and milk yield.

Exotic breeds of dairy and beef cattle and their characteristics

Dairy and beef cattle can be noticed so easily by looking at their general characteristics as listed:

Dairy cattle

The characteristics of dairy cattle may include the following:

- The animal should have a wedge shaped appearance of the body.
- They have a large stomach.
- The udder should be well attached to the abdomen.
- The skin of the udder should have a good network of blood vessels.
- All four quarters of the udder should be well demarcated with well-placed teats.
- They have short and well set legs to support the body.
- They are good foragers and are; able to convert forage into more and good quality milk.
- Dairy cows should be docile and have good temperament for easy handling.

Fig. 12.1 Exotic breeds of cattle

Beef cattle

Beef cattle have some characteristics which distinguish them from dairy cattle. These characteristics are more easily observed in exotic breeds than indigenous beef cattle. These characteristics are as follows:

- They have deep bodies with short legs that are well spaced apart.Udders are small
- They have a stocky square body with a lot of flesh which is well distributed
- They have fast growth and maturity rates.
- They are able to convert forage to good quality meat.
- Their top and lower lines are almost straight with the brisket protruding forward.Hips and loins are well covered with flesh.

Figure 12.2 shows some beef cattle

Charolais cattle Brahman cattle

Figure 12.2: charolais and brahman beef cattle

Table 12.1 gives individual exotic dairy and beef cattle characteristics

Table 12.1: characteristics of exotic breeds of dairy and beef cattle

Dairy cattle	**Beef cattle**
• **Jersey** • Body colour is grey • Body size is medium to small • Milk production is moderate • Feed requirements are relatively low • Milk has high butter fat • Gives 2700kg of milk per lactation period	• **Boran** • Body colour is brown or light grey • The breed has a prominent hump • Beef production is good • They are good for harsh conditions • Average live weight is 500kg
• **Guernsey** • Body colour is brown • Body size is medium	• **Hereford** • Body colour is black or brown with white head

• Milk production is moderate • Gives 3000kg of milk per lactation period	• Beef production good • Forage requirement high • Average live weight is 850kg for cows and 1000kg for bulls
• **Friesian** • Body colour is black and white • Body size is large • Milk production is high; it is about 3500kg per lactation period • Feed requirements are very high • Meat production is high • The cow's milk has low butter/fat content • Average live-weight is 600kg • She is very sensitive to management	• **Charolais** • Body colour is creamy white • Beef production is good • Forage requirement is high • Average Live Weight range from 1000 -1200kg
• **Aryshire** • Body colour is dark brown with white patches • Milk production is high, it is about 3300kg per lactation period • Feed requirements are high • Her milk has relatively low butter fat content • Average live weight is 450kg	• **Simmental** • Body colour is Brown with white on the head and legs • Meat production is high • Forage requirements are high • The Breed requires high standards of management • Average live weight is 750kg

	• **Africander** • Black in colour • Has good resistance to heat • Good temperament • High level of fertility under harsh conditions • Mature cows weigh approximately 525 to 600kg and bulls weigh 750 to 1000kg.
	• **Brahman** • Come in two colours: white or grey • Have a hump above the shoulders and pronounced dewlap • Medium in size • Carcases of young animals tend to be lean

MANAGEMENT OF DAIRY AND BEEF CATTLE

Management of dairy cows

Proper management of dairy cows helps to produce a lot of milk. The conditions that aim at improving milk yield in dairy production include selection of quality breeds of cows, carrying out routine activities in order to keep them healthy at all times and following proper milking procedures. Malawi zebu is the indigenous breed that is regarded as a source of milk. However milk yield is generally low. Farmers can improve milk yield by raising improved breeds of dairy cows. Among the exotic breeds of dairy

cows, Friesian provides a lot of milk of about 3500 kg per annum. Therefore farmers are encouraged to use Friesian and its crosses with Malawi zebu since the Malawi zebu is adapted to local conditions hence the crosses may not only be high yielding but also have the ability to withstand local conditions.

Milk is produced at both large and small scale with varying levels of intensification. The smallholder farmers manage their dairy cows mainly under zero-grazing and semi-intensive systems where exotic and cross-bred cows are raised. The farmers give the cows roughage as their main source of energy and also use by-products of arable crops. Therefore small-scale dairy production is facilitated by integration of livestock keeping with growing of food crops like maize, beans, ground nuts, wheat, rice and bananas.

Housing

A good house for dairy cows has the following qualities:

- Well ventilated and spacious
- Well drained khola
- Well thatched
- Should have enough beddings on the floor
- Well lit
- Should have separate rooms for calving, breeding, feeding, exercise, milking and drenching.

Therefore, two dairy cows require a khola size of 3.7 metres wide, 6.1 metres long and 2.4 m high. Farmers are encouraged to raise two cows because it is not only affordable but also easy to detect heat period as it has the tendency to ride and to be ridden. Farmers are strongly encouraged to place beddings in the khola. The commonly used kholas is a simple pole and thatched one which is made of low-cost locally available materials.

Some farmers use an iron-sheet roof. It is also important to include a milking parlour (shed), exercise yard and parasite and disease control pen. The khola should be constructed with a slight slope for drainage purposes and also on a windward side to avoid smell.

Figure 12.3 shows one of the well-built pole and thatch dairy khola.

Fig. 12.3: A pole and thatch house of cattle

Activity 12.1

Visit a nearby dairy farmer and inspect how the khola for the dairy animals has been constructed.Look at the space, slope of the floor, ventilation and hygiene. Does the khola have the feed trough, water trough, separate rooms for breeding, drenching/vaccination, exercise and milking?

Write a report on the findings and in your report include the following:

- *The condition of the khola.*

Dairy cows are ruminant animals so their main source of food is roughages. However farmers can obtain more milk production if the dairy animals are fed on roughage and concentrates.

As we have already learnt that most dairy farmers practice integration of animals with arable crops so that they use the by-products of arable crops as supplementary feeds to the animals, dairy animals are given star grass, ground nut haulms, maize stover, dry leucaena or sesbania leaves, banana stems and leaves, silage, hay, elephant grass and other pasture grasses for maintenance purposes but for production of more milk supplementary feeds in the form of concentrates are given to the dairy cows. The sources of concentrates include maize bran (madeya), soya meal, cotton seed cake, bean meal and rice bran. In order to increase production at a cheap cost, the combination of these feeds is done.

The guidelines to proper mixing of roughage and concentrates for better or improved milk production are as follows:

- Feed 1 kg concentrate ration for every 2 kg of milk the cow produces.
- Feed 2-4 kg of feed per 100 kg live weight per day for maintenance and a limited amount of milk production.
- Give 65 parts of madeya, 34 parts of dry leuceana or sesbania leaves and 1 part salt when the farmer cannot manage to purchase formulated feeds. This is done at a rate of 4 kgs per day.
- Provide 45 litres of fresh clean water to each animal every day.

Breeding

Proper breeding in dairy cows starts with selection of quality cows and once a good quality cow has been obtained, breeding follows. It is important to breed cows that will be capable of producing at least once a year. This is achieved if breeding is done at the right time.

The right time to breed dairy cattle is when they reach the right age and proper body weight. It is recommended that heavy breeds of dairy cows should be served at the weight of 280-320 kg, light breeds at 250-270 kg and indigenous Malawi Zebu at 250 kg. The recommended breeding ratio of one bull to heifers is 1 to 20 or 30.

The farmer is encouraged to observe the cows when planning for a breeding program. This is because the cows are mated when they are on heat. The best time of the year to breed the cows is when they will give birth about 1-2 months before the rains start. Generally this should be during the second and third month of the year.

Activity 12.2

What are the signs of heat? Remind each other in groups and present the results in class.

As we earlier discussed, animals accept to be mated if they are on heat. Likewise dairy cows are mated when they are on heat. Cows come on heat once every 21 days and the heat period lasts 18-30 hours. When the cow is served the gestation period takes about 283 days.

The farmer should make sure that mating is being facilitated to ensure that the right animals are mated. Sometimes the farmer may use artificial insemination (AI) to acquire high quality bulls by importation of sperms. This is done among other reasons to prevent sexually transmitted diseases.

The use of AI depends on the level of management since it is expensive to use and maintain.

Caring for pregnant cows

Mating results in pregnancy if successfully done. Such a cow is also referred to as an**in-calf cow** or **in-calf heifer**. The cow needs to be fed properly throughout the gestation period. During this period the farmer continues to milk the cows which have once given birth as milking starts 2-3 weeks after parturition and stops 2 months before parturition. This period which the farmer stops milking the cow; is called the **dry off period**. This is the period which prepares the cow for the young one to be born and hence the cow must not be disturbed. During this period, the farmer should give the cow extra feeds in the form of concentrates. This is called **steaming up.** Steaming up is done in order to raise up the plane of nutrition of the cow until the calf is born.

Management of calves

A successful gestation period ends up with calving and the farmer must get prepared for it. 2-3 days before calving, the in-calf heifer should be put into a separate pen and kept under a close watch until she gives calves since sometimes assistance during calving may be needed if the position of the foetus is not well presented in the womb and this is called **breech position.**

After birth, the mucus and amnion should be removed on the mouth and nose of the calf to make sure it breathes properly. The calf is kept in-doors on a straw bed (on beddings of crop residues). This is done mainly during the cold weather.

The calf is allowed to receive colostrum or first milk from the mother. This milk is rich in antibodies, vitamins and proteins. The calves are allowed to suckle from their mother for 1 week and from 2 weeks until

weaning(three months), the calves are fed on whole milk or its substitutes. Sometimes the calves are transferred to a foster mother. Solid food is gradually introduced from 3 weeks old.

Practices done when rearing calves

a. Dehorning

Dehorning is the removal of horns and is best done when the calves are 2 weeks old.

b. Castration of bull calves

Castration is the removal of the testes to prevent undesirable mating of animals. It is best done when they are 3 months old when the reproductive parts can be recognised.

c. Branding

Branding is the application of identification marks such as ear tags or tattoos for easy record keeping.

d. Disbudding

This is when the horn buds are stopped from growing.

e. Drenching

Drenching is done to control internal parasites

f. Vaccination

Vaccination is mainly done to prevent calf hood diseases.

When calves reach the age of three months, they should be weaned. Weaning is when the calves are separated from their mother and this practice is important as the farmer obtains all the milk produced by the cows. It is important that each weaner calf should be placed in a separate pen where they will be fed differently. Each pen should have the necessary facilities for feeding and watering. If the calves are kept in-doors, they should be released occasionally for exercises. This should be done

alternatively with cleaning. If they are kept out-doors, then calves should be rotated to fresh sheds.

Heifer calves (female calves) should be managed properly for them to grow so that they can be bred at an early age. To ensure rapid growth, heifer calves are fed on two types of feeds namely:

i. Pasture: this is cheap but the farmer should make sure that heifers are fed on quality pasture.
ii. Concentrates: the farmer should make sure that pasture is supplemented at times with by-products of arable crops. These include madeya, soybean meal, rice bran, groundnut flour, bean meal and cotton seed cake.

The farmer should also note that heifers may not grow fast if they are diseased hence proper hygiene is vital. Weaners should be dipped and drenched against parasites and vaccinated.

Heifers are ready for mating when they are 18 months old but proper breeding stipulates that heifers should be mated when they are 2 years old. Once they are served, they need to be properly fed. Heifers do not require special houses and need to graze outdoors in paddocks.

Milk production

The primary product from dairy cows is milk. This milk is produced by lactating cows soon after calving. However, farmers are advised not to start milking soon after calving as the milk's colour is not fully cream white. This milk cannot fetch good prices at the market hence the farmer should wait for a week or so that quality milk starts coming out.

Factors affecting milk production in cows

Health of the animal: Milk yield and quality is affected by diseases. Cows which are in good condition produce a lot of milk and of good quality.

Availability of feeds: cows need to be given enough quality feed. This affects quantity of milk produced.

Age of the animal: Cows tend to give more milk as the number of lactations increase up to the seventh to eighth lactation. Then milk yield drops as the number of lactations increase. Young heifers tend to give milk richer in nutrients such as butterfat.

The mood of the animal: if the cow has a good temper, she produces a lot of milk. The temper is affected by how the cow is being handled during milking. Therefore cows tend to be handled gently during milking for maximum milk production.

Milking interval: Cows produce a lot of milk per day. The greater the amount of milking done the more labour is required. Therefore farmers should strive to milk their cows at least two times a day.

Heat period: Cows on heat tend to give low milk yield. Its quality is also reduced.

Temperature: The higher the temperature the lower the milk yield. In order to keep temperature at optimum levels, farmers should thatch the kholas and plant trees to provide shade in the grazing paddocks.

Milking cows

Milking is the process of removing milk from the udder after a successful let-down into the bucket. This is done by hand or a machine. Using a hand squeeze method, the teat is held between index finger and thumb. The fingers compress the teat to obtain milk. Then the index finger is relaxed to allow the teat canal to refill. Milking continues. A milking machine has

metal teat cups which fit over the cow's teats which suckles milk into a bucket unit.

Milking process

Milking process involves the following:

- Collecting all equipment to be used. All the equipment collected should also be clean and the farmer should clean her hands with soap.
- Taking the cow into the milking parlour (milking place). Cleaning the udder and the teats with warm water and disinfectants. Use a separate cloth for each animal. Warm water induces milk let-down. The udder should be mopped and have a milk salve applied to it.
- Checking for mastitis (inflammation of the udder) before milking. If the cow is suspected of having mastitis, it should be milked last.
- Placing feed in the feeding troughs. This is done because it is important that as the cow is being milked, she should be eating.
- Choosing the technique of milking and then starting milking the cow. As already mentioned, smallholder farmers should use the hand method as it is cheap. The farmer should exhaust all the milk in the udder to avoid build-up of mastitis. The cow should be milked fast and gently to avoid leaving out milk and bruising the teats. Therefore milking is done within 10 minutes to avoid milking the cow heavily. The cow should be milked twice a day.
- Weighing the milk using a sieve. Farmers can use a dry clean white cloth as a sieve.
- Cleaning the parlour and all utensils after milking.

Figure 12.4 illustrates the milking process using a milking machine.

Fig. 12.4 Milking a cow using a machine

The milking process should maintain an 8 hour milking interval during the day and it is important to reserve 1 teat (quarter) for the calf. The calf should suckle for 30 minutes and thereafter be separated from the cow.

Activity 12.3

How can a farmer obtain clean milk? Visit a nearby dairy farmer and observe what practices are done in order to obtain clean milk.

Milk is one of the perishable agricultural products but also the most balanced food. This means that it attracts both harmful and harmless organisms. To obtain uncontaminated milk, the farmer milking the cow should ensure the following:

- Maintaining clean and healthy cows. Cows should be free from contagious diseases like tuberculosis, brucellosis and mastitis. This is achieved by keeping the animals and surrounding clean.
- Keeping milking and feeding utensils clean by disinfecting them.
- The farmer should always be clean when checking and milking the cows.
- The farmer should apply milking salve to the teats to avoid lesions or inflammations on the teats.
- After milking, milk should be placed in a cooling machine (refrigerator) so that milk is cooled to a temperature of less than 4^0C.
- Containers containing milk should always be closed to keepaway flies and other contaminants.

Marketing milk

There are milk collecting centres which are established throughout the country where milk is purchased through bulking groups and collected by commercial dairies. Farmers are encouraged to form groups around each milk collecting centre. The advantages of these groups are:

- Groups facilitate the distribution and management of inputs
- Groups facilitate training, demonstrations, dissemination of messages and feedback
- Groups encourage active participation of members in the dairy industry.

Farmers should get rid of excess heifers by selling them to fellow farmers.

Management of beef cattle

Beef cattle are managed using two major types of systems namely traditional and commercial. The traditional system is characterised by

grazing the animals on communal land where natural pastures are found. This is generally in dambos. Farmers may also graze their animals in people's farms after harvesting during the dry season to feed on crop residues such as maize stover, potato vines and groundnut haulms. This system is commonly practised by small holder farmers since it is cheap. However animals produced are of poor quality and fetch low prices at the market. Animals may also contract diseases easily as they are exposed to bad weather.

The commercial beef production system is practised in two ways; ranching and stall-feeding. Ranching is the system where cattle are fenced in a large piece of land where they feed on natural grasses and shrubs which are maintained through good grazing management and proper stocking rates. In ranches, farmers may breed animals and also fattern them to market weight. This system has the following advantages:

- It is cheap since animals feed on natural grass.
- Control of parasites and diseases is easy as animals are controlled easily.
- Predators and thieves are controlled easily because of the fence.

However fencing may be expensive.

Stall-feeding system is also known as zero-grazing where animals are enclosed in the khola where they are fed on grass and concentrates. Clean fresh water is also given to the cattle. This system is important because animals fatten up quickly and reach market weight fast but also diseases and parasites can be controlled easily. However the disadvantage of this system is that it is very expensive to maintain.

Figure 12.5 shows an example of a stall feeding of cattle.

Fig. 12.5 Stall-feeding

Farmers can minimize the costs that could be incurred under stall-feeding system by doing the following practices:

- Place weaned calves of about 250 kg in the khola
- Feed them on roughage (pasture grass) i.e. hay, silage, groundnut haulms, banana leaves, fresh grass, dry potato vines and other crop residues. This can be done for about four months.
- Thereafter feed the animals on concentrates for three to four weeks. This will make the animals fattern up.

Under this system the beef animals can be kept for approximately 30-40 months.

Breeding

Malawi zebu is regarded as the main beef cattle by most smallholder farmers in Malawi. This breed of beef cattle has poor qualities since it grows slowly and gives low meat yield. Malawi zebu can be improved in

order to increase meat production but also growth rate so that farmers are able to increase yield.

Therefore Malawi zebu can be cross-bred with the exotic breeds like Brahman, Hereford, Charolais and others. The farmer should make sure that good quality bulls and heifers are chosen for breeding. All animals selected for breeding should have a good calving rate.

Bulls can start to serve or are ready for mating at the age of 18 months while the heifers should be at the right body weight of about 250-260kg. The breeding plan should consider that calving should take place when there is plenty of feed mostly two months before 1-2 months before the rains start. The gestation period of cows take 283 days which is approximately 9 months. As discussed earlier in the chapter, animals in gestation need to be fed well and protect from parasites and diseases through regular vaccination, drenching and spraying. When the cow is two to three months before calving, the cow should be given enough quality feeds and freshwater. Feeding pregnant cows 2-3 months on concentrates is done mainly to boost the growth of the foetus and keep the cow in good health so as to sustain the foetus. This is called **steaming- up.**

Caring for beef calves

Routine practices are done when managing beef calves as discussed earlier under dairy production. These practices include castration, dehorning, disbudding, branding, regular vaccination and drenching.

Beef calves are weaned after 6-8 months and this time calves are separated from mothers. Heifers are also separated from bulls to avoid uncontrolled mating. In order for weaners to grow fast, they must be given good quality feeds and routine drenching and vaccination is vital.

Raising weaners at 18 months old

These are divided into two groups:

a) Breeding stock i.e. heifers and bulls

b) Fattening stock i.e. steers, heifers and bulls

The breeding stock are given quality feeds to stimulate fertility fatten the stock. They are placed in the fattening pens and then fed intensively on good pasture grass, e.g. elephant grass and vertiver grass during the first few days. When they are about to be slaughtered, that is into 3-4 weeks time, calves are given concentrates in the form of maize bran, rice bran, groundnut cake, soya meal and fish meal so that they fatten and reach the desired slaughter weight. This is called **finishing up.**

Therefore, the fattening stocks are beef weaners raised in the stall-fed khola so that they reach the slaughter weight fast. Small holder farmers can also raise fattening stock cheaply by taking them to grazing areas and supplement whatever they eat with crop by-products like madeya, maize flour, processed cassava and soya bean meal.

Housing

Beef cattle need a quality house just as any other animal. However, houses differ based on the type of system being practised. The commonly used khola in Malawi is a pole and thatch one. These kholas should be constructed in such a way that animals are comfortable. Therefore a khola space for one steer should be 2.1 metres long, 2.1 metres wide and 2.4 metres high. The length of the khola may depend on the number of animals to be stall-fed. It is recommended that each animal has its own pen for better management and in each pen, beddings, feed and water troughs should be provided.

Feeding

Most smallholder farmers take their beef cattle to graze in the communal grazing land as discussed earlier in this chapter. However, some small holder farmers can practice the stall-feeding system by using the following guidelines:

- Stock steers weighing 250 kg live weight with 4 to 6 permanent teeth in separate pens.
- Feed them intensively for about 30-40 days by giving them 5kg per animal per day of cut grass, banana stems, and potato vines mixed with maize bran. Madeya is fed at 6.5kg per animal per day if roughage intake is restricted.
- Give 4kg maize bran mixed with leucaena leaves in proportions of 4 parts maize bran to 1 part dried leucaena leaves.
- Cross-bred steers from Friesian or Brahman should be fed on 1 to 2 kg more supplement than Malawi zebu because of their higher maintenance requirements due to their larger body size.
- When feeding maize stover with groundnut haulms, the best combination is 50 parts of maize stover to 50 parts of groundnut haulms supplemented with 5 kg of maize bran. The higher the proportion of groundnut haulms in the roughage, the greater the expected live weight gains by the steers.

Marketing beef cattle

*Most c*attle owners do not sell their animals at the right time. They often sell cattle to local butchers when need arises. Farmers are supposed to cull old and unproductive animals at the right stage and fatten them before marketing.

There are several cattle markets country wide. These markets are owned and managed by farmer groups. Through these markets, farmers are able

to sell their cattle at a reasonable price because the animals are auctioned and the buyers bid. Farmers assisted by the government set guaranteed minimum floor prices for various grades of cattle as shown in table 10.2. Farmers are encouraged to sell their animals at these markets because they obtain more money and livestock theft is controlled. Farmers selling cattle must process valid livestock movement permits for animals being sold. The licence ensures proper ownership over what the cattle farmers are selling, checks the spread of diseases, slaughter of young breedable stock and also eliminates livestock theft.

Table 12.2: Description of various grades of beef cattle

Grade	Description
Standard	Well fleshed and medium sized cattle. Bulls are fat.
Commercial	Cattle are in a reasonable condition.
Inferior	Cattle which are below the standard of the foregoing grades.
Feeder grade A	Cattle with a minimum live weight of 250 kg. The cattle has up to four. The cattle are under intensive feeding.
Feeder grade B	These are cattle with not more than six permanent teeth and a minimum live weight of 225 kg.

Parasites and disease control of beef and dairy cattle

Parasites of cattle

Parasites may be categorised as external and internal depending on where they live when feeding on the animal. The external parasites that are of economic importance in cattle production are ticks and tsetse flies.

Dairy and beef cattle ticks

Ticks are the main external parasites of cattle that are responsible for transmission of serious diseases. These parasites are mainly found on almost all the parts of the cattle. The life cycle of ticks takes four stages namely eggs, six-legged larva, eight-legged nymph and eight-legged adult. Ticks are also found in four species namely blue ticks, bont ticks, brown ear ticks and red-legged ticks.The life cycle of each of these species differs on number of hosts they need to complete their life cycle.

Damages caused by ticks

- They suck blood from the animal. As a result animals suffer from anaemia.
- Ticks irritate the animal.
- They transmit tick-borne diseases like redwater, gall sickness, anaplasmosis, heart water and east coast fever.
- They cause wounds on the skin of the animal due to tick bites or mechanical damage as the animal tries to scratch due to itching which may be a source of infections.
- They affect the production of meat and milk in cattle by lowering the quantity and quality of products.

Types of life cycles of ticks

One-host cycle

A one-host cycle is a life cycle that is completed on one animal. The species of ticks that undergo this life cycle is the blue tick. These ticks lay eggs on the ground and hatch into six-legged larvae that later climb onto the host. The larva moults to an eight-legged nymph and then an adult while still feeding on the same host. Female adults fall on the ground to lay eggs after mating. This means blue ticks spend their entire life feeding

on a single host. Figure 12.5 shows the life cycle which is completed on one-host.

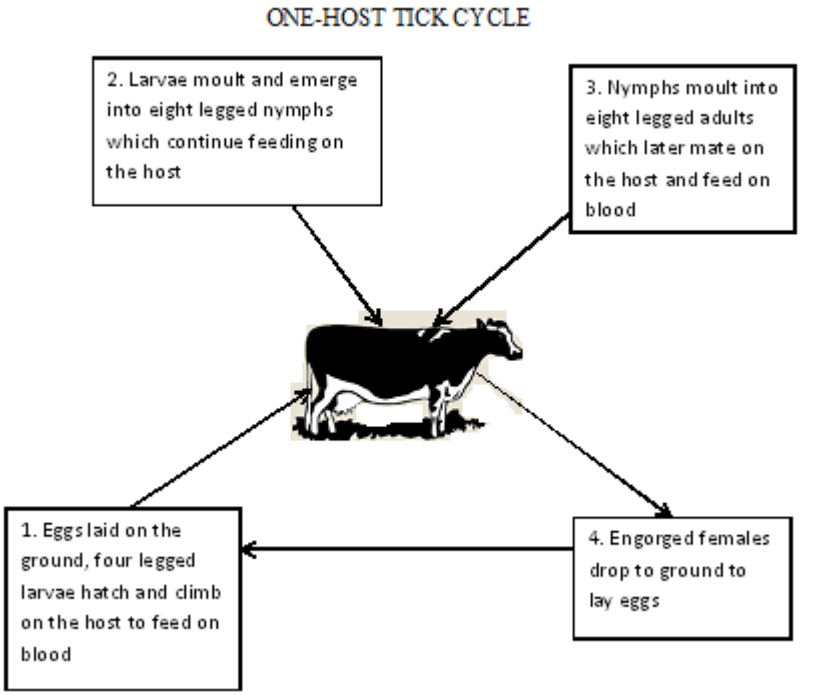

Fig. 12.5 Life cycle of a one-host tick

Two-host cycle

Eight-legged ticks have their cycle completed on two hosts. What happens is that once eggs hatch into six-legged larvae, they climb on the first host and feed on it and then moulting occurs on the same host into eight-legged nymphs. These nymphs continue to feed on the same host. When the nymphs are about to moult to adults, they fall down and moult into eight-legged adults which later climb on the second host where they feed and mate. After mating the female adult fall on the ground to lay eggs. Figure 12.6 illustrates what happens in the two-host cycle.

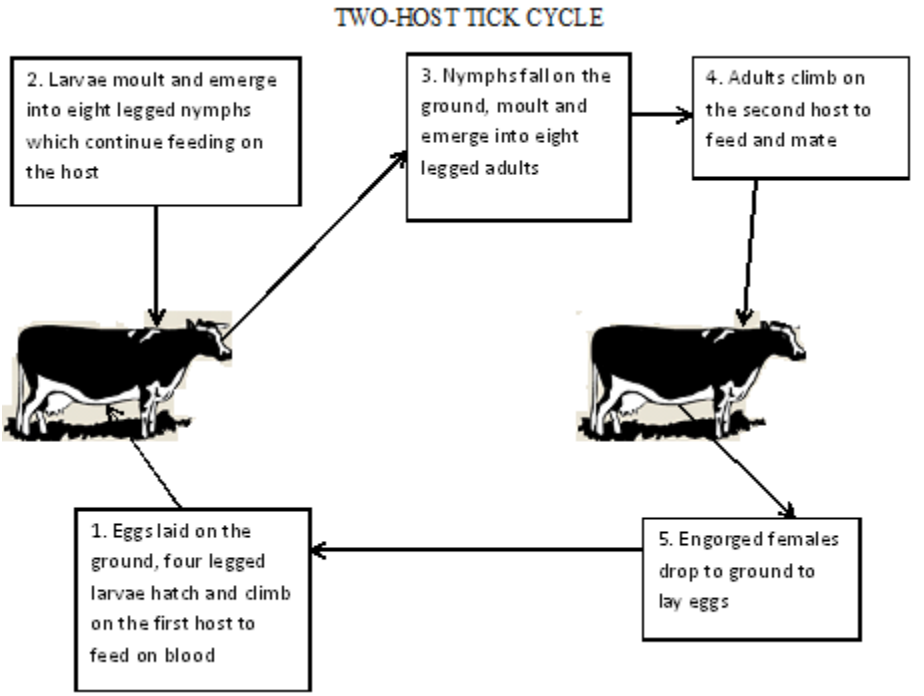

Fig. 12.6 Life cycle of a two-host tick

Three-host cycle

Bont and brown-ear ticks complete life cycles on three hosts. Each growth stage occurs on different hosts. Figure 12.7 is an illustration of a three-host tick cycle.

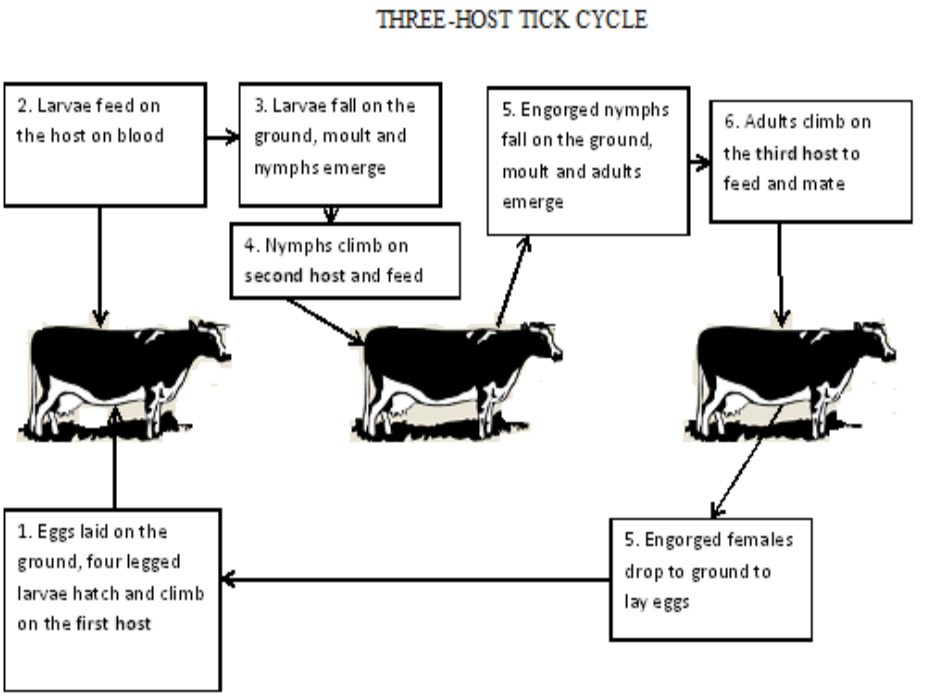

Fig. 12.7 Life cycle of a three-host tick

Activity 12.4

Why is it important to study and know about the life cycle of ticks? Discuss this in your groups and present the reasons in class.

You may have discussed that it is indeed necessary to know the type of life cycle of each tick for easy control of the ticks. Generally ticks are controlled by dipping and spraying when there are many animals since this

is economical, but if they are few animals (1 or 2 or 3) then hand spraying is feasible. Dipping uses a dip tank and spraying uses either sprayer or a spray race. Figure 12.8 shows a dip tank, spray race and a farmer spraying an animal against ticks using a sprayer.

Fig. 12.8 Methods of controlling tick

Tsetse flies

The tsetse flies suck blood and weaken the animals. They also transmit trypanosomiasis. Farmers can control them by clearing the bush and spraying the animals.

Internal parasites

These are organisms which live inside the body of animals. The common internal parasites of cattle are round worms, tapeworms and liver flukes. Roundworms and tapeworms are usually found along the alimentary canal while liver flukes are found in the bile duct or the liver.

Table 12.4 Description of internal parasites of cattle.

Parasite	Damage	Control
Round worms (found in the alimentary canal)	• Absorbs a proportion of animal's digested food	• Grazing animals in a well-drained pasture • Quarantine new stock and treat for roundworms • Treat affected animals with phenothiazine or thiobenzol. Make sure phenothiazine is not used for lactating goats and sheep as it appears in the milk.
Tapeworms (found in the muscles, lungs, liver, brain and intestines)	• Larvae gets into the blood or lymphatic vessels affecting translocation of absorbed food • Adults attach themselves in the small intestines where they feed on digested food	• Practicing rotational grazing • Treating animals with copper sulphate at 6 week intervals
Liverflukes	• Transmit a disease called fasciolasis or distomatosis	• Drenching animals with antihelmintics

	• Inhabit bile duct resulting in liver damage • Cause anaemia due to liver damage • Digestive upsets due to blocking of the bile duct	• Practice controlled grazing and keep animals away from areas with stagnant water • Control secondary or alternate hosts by destroying snails with copper sulphate • Draining swampy areas

Diseases of cattle

Mastitis

Mastitis disease is caused by bacteria and mechanical damage of the udder due to bruising and improper milking.

Signs

- The udder swells and milk is mixed with blood clots.

Prevention

- Proper hygiene in the khola.
- Good milking practices i.e. milking the cows gently, completely and frequently.

Treatment

- Injecting the cows using antibiotics like streptomycin.
- Wash the udder with warm water and some salt.

Anthrax

Anthrax is caused by bacteria (*Bacillus anthracis)*

Signs

- Animals have fever and high body temperature.
- Causes death in most affected animals.
- Oozing of blood from the nose and anus.

Prevention

- Annual vaccination with Blanthrax.
- Isolation of infected animals.
- Burning all dead animals and burying them.

Foot and mouth

Foot and mouth is caused by a virus.

Signs

- High fever accompanied by a sharp rise in temperature.
- Painful blisters around the mouth, udder and between the hooves.
- Excessive salivation.
- Difficulties in eating.
- Lameness.
- Loss of appetite.
- Reduced milk yield.

Prevention

- Vaccinating animals
- Quarantine animals

Trypanomiasis (Nagana)

Trypanomiasis is caused by a protozoon which is called trypanosomes and it is transmitted by tsetseflies.

Signs

- High temperature.
- General body weakness.
- Anaemia.
- Loss of appetite.
- Animals die eventually.

Prevention

- Clearing the bushes which are breeding sites for tsetseflies

Treatment

- Using drugs like Berenil, antricide and samonin

Heartwater

Heartwatr is caused by bacteria and is spread by ticks. It is called a tick-borne disease.

Signs

- Highfever
- Animals become restless and place heads on hard objects
- Quick uncontrollable movement of muscles
- Coma before death
- Post-mortem shows yellowish brown fluid in the heart and abdominal cavity

Treatment

- Tickcontrol by dipping
- Treat early cases with tetracycline antibiotics

East coast fever

East cost fever is caused by protozoa and transmitted by brown-ear tick

Signs

- High temperature
- Small haemorrhages in vulva and oral mucous membranes
- Loss of appetite
- Diarrhoea

Prevention

- Tick control
- Quarantine the animals

Rinderpest

Rinderpest is also called cattle plague. This disease is highly contagious and infectious. It is caused by a virus.

Signs

- High fever
- Diarrhoea
- Sores in the mouth and nose
- Fast breathing

Prevention

- Killing all the flock and disinfecting the houses
- Quarantining the animals when there is an outbreak
- Vaccinating the cattle from about one year old every year

Blackquarter

Blackquarteris an infectious disease caused by bacteria.

Signs

- High fever
- Shivering
- Dullness
- Loss of appetite
- Lameness

Prevention

- Treat animals with antibiotics
- Vaccinating animals every year
- Burning all dead animals and burying them

Tuberculosis

Tuberculosis is caused by bacteria called *Mycobacterium tuberculosis*

Signs

- Respiratory problems
- Soft cough which increases later
- Temperature fluctuates
- Emaciation and diarrhoea
- Vaginal discharge which is white
- Animals may be sterile

Prevention

- Test cattle with tuberculin and kill infected animals
- Vaccinate young animals

Red water

Red water is caused by protozoa and transmitted by ticks

Signs

- High temperature
- Animals become anaemic

- Red blood pigments in the urine

Prevention

- Control ticks
- Treat cattle with suitable drugs such as Babesian and Acaprin

Gall sickness

Gall sickenss is caused by bacteria and is spread by ticks.

Signs

- High temperature
- Loss of appetite
- Mucous membranes which are pale
- Deaths

Prevention

- Treat cattle with tetracycline
- Tick control

Milk fever

Milk fever disease affects cows three days after calving. It is caused by low levels of calcium in the blood stream.

Signs

- Excitement of cows and then they fall to the ground
- Oozing of saliva from the mouth
- Temperature of the cows drop

Prevention

- Add more calcium contents in the feed
- Inject small doses of Calphon into the veins

Contagious abortion (Brucellosis)

Brucellosis is caused by bacteria called *Brucella abortus.*

Signs

- There is abortion followed by brownish vaginal discharge
- Retention of the placenta
- Swollen testicles in young bulls

Prevention

- Kill all infected animals
- Vaccinate all young females below 12 months
- Boil milk from infected cows before drinking

Calf scour (calf enteritis)

Calf scour is an acute disease of calves up to 3 months old. It is characterised by diarrhea. It is caused by bacteria called *Escherichia coli* but also poor management.

Signs

- Diarrhea-watery discharge
- High temperatures
- General body weakness
- Death

Prevention

- Good management
- Segregate affected animals

Summary

- *Dairy cattle are animals bred for milk production.*
- *Beef cattle are animals bred for meat production.*
- *There are two breeds of dairy and beef cattle namely; indigenous and exotic breeds.*

- *Local breeds of dairy and beef cattle are known for their low milk and meat production, but can be improved by cross-breeding them with the exotic breeds.*
- *The local breed which is used for milk and meat production in Malawi is Malawi zebu.*
- *Dairy breeds are characterized by their wedge shape, large stomach, larger udder with well-placed teats, good foragers and they are docile and have a good temperament. Exotic dairy breeds include Jersey, Guernsey, FriasianandAryshire*
- *Beef cattle are characterized by having deep bodies with a lot of flesh , have a rectangular or square body shape, grow and mature fast, good foragers and they are short. Exotic beef breeds include; Boran, Hereford, Charolais, Simmental, Brahman and Africander.*
- *Management of dairy and beef animals involves proper feeding, breeding, housing, and parasite and disease control.*
- *Proper management of cattle leads to high production of meat and milk.*

End of chapter exercise

1. Name three exotic breeds of dairy cattle.
2. Mention two characteristics of dairy cattle.
3. Describe any two systems used in beef cattle management.
4. Describe precautions necessary to obtain clean milk.
5. Explain any four management practices in calf rearing.
6. Describe five important diseases of beef and dairy cattle.
7. With the aid of a well labelled diagram, describe the life cycle of three-host ticks.

GLOSSARY

Anaplasmosis: a disease of cattle that is transmitted by cattle ticks
Breech position: delivery of young one whose hind legs appear first
Bruise: damage of mangoes caused by friction
Bulking: gathering or assembling of agricultural produce into large quantities
Bumper yield: extraordinarily abundant yield
Calving: giving birth to a calf
Canning: process of preserving agricultural produce or product in the sealed metal tin or can
Chaff: material consisting of seed coveringsand a small pieces of stems or leaves that have been separated from its seed
Cow: female cattle
Cultivars: (cultivated plants) a variety of a plant developed from a natural species and maintained under cultivation
Deviation: the difference between an observed value and the expected value of a function
Dormancy: a condition where a viable seed is temporary inactive
Drenching: giving drugs to livestock through the mouth
Eelworms: any of various small free-living plant parasitic roundworms
Emaciation: extreme leanness as a result of starvation or disease
Emasculation: removal of anthers in plants before they mature
Hamper: to be put at a disadvantage
Hybridization: (genetics) the act of mixing different species or varieties of plants and animals to produce hybrids
Impact: having an effect upon something
Inbreeding: the act of mating closely related organisms
Inflammation: a response of body tissues to injury or irritation characterized by pain and swelling and redness and heat

Intermediaries: marketing agents who link farmers and other agents i.e. wholesaler or consumers
Irritate: cause annoyance or disturbance to the livestocks
Lactation: feeding young animals by giving suck at the udder
Magnitude: of relative extent or size
Mitigate: to lessen the severity or seriousness of climate change
Mixed stand: pasture field containing more than one type of pasture species i.e. grass and legume pasture species
Modern: recently developed
Palatable: acceptable to the taste
Parturition: giving birth in animals
Perishable: subject to get damaged easily
Power: ability to do work
Pruning: act of trimming a plant part
Pure stand: pasture field containing only one type of pasture species
Quarantine: an enforced isolation to prevent spread of contagious disease
Residues: crop remains in the field
Runoff: an occurrence of surplus water exceeding the water holding capacity of soil
Shelf-life: a period of time assigned to an item before it reaches its end of use
Shivering: a sensation of cold that marks the start of an infection and a development of a fever
Silking: placing a bag over the ear before the stigmas emerge
Soak: to be softened or saturated with water
Strip cropping: cultivation of crops in strips following the contours of the land to minimize erosion
Toxic: being poisonous
Traits: a distinguishing feature in organisms
Unisex: not distinguished on the basis of sex
Vegetative material: plant part used to produce new plant
Viable: capable of life or normal growth and development

Vigour: an improved performance in plants
Wean: separate young ones from their mothers
Widened: (of marketing channel) broadening of a marketing channel due to increase of marketing agents

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