CPS

Secondary

Agriculture 2

Learner's book

FORM 2

Domhani F Nhundu E Shava R Zinengeya D

CPS | Secondary

Agriculture 2

This Junior Secondary Agriculture book gives an extensive and deep coverage of Form 2 agriculture requirements of the updated curriculum (Ministry of Primary and Secondary Education 2015 – 2022). The book covers land use forms, forestry, wildlife, soil science, plant classification, crop production, crop protection, animal husbandry, farm machinery and agribusiness. Exciting activities and experiments are lined out to develop learners to appreciate gender equity, team work, safety, environmental issues and entrepreneurship.

This book offers:

- Logically sequenced content to help learners understand learning areas
- Appropriate language and terminology for the level of learners
- Variations in topic presentations balancing between theory and practice
- Live and vivid illustrations that captivate the minds of the learners making the learning of agriculture interesting
- Activities that motivate, challenge learners, and encourage teamwork in solving problems theoretically and practically
- End of chapter questions that link theory and practice to assess learners' mastering of agricultural knowledge and skills
- Specimen questions to consolidate the key concepts taught and syllabus objectives

Approved by the Ministry of Primary and Secondary Education, September 2017

CPS | CONSULTUS PUBLISHING SERVICES
...in class with you

ISBN 978-0-7974-7343-0
9 780797 473430

CPS | Secondary

Agriculture 2

New Curriculum

Learner's book

Domhani F Nhundu E Shava R Zinengeya D

CPS | CONSULTUS PUBLISHING SERVICES

CPS CONSULTUS PUBLISHING SERVICES

1515 Tourle Road, Ardbennie, Harare

Agriculture 2 - Learner's Book

First published November 2017

ISBN:978-0-7974-7343-0

Publisher : Mwazvita Patricia Madondo

Edited by: Sophia Gwakuka
Mwazvita Patricia Madondo

Cover design: Masimba T. Madondo

Cover atwork from Pixabay

Illustrated by: Danson N. Zinengeya

Text and design layout: Victor Mupangami

Printed by: DP Printmedia

Pictures

Pixabay: Fig 1.3, Fig 1.4, Fig 1.6, Fig 1.9, Fig 1.10, Fig 1.12, Fig 1.13, Fig 1.14, Fig 1.15, Fig 1.16, Table 2.1 flame lily, python, fish eagle, rhinoceros, cheetah, Fig 2.12 lion, cobra snake, leopard, Fig 2.13 baboon, hyena, and fig 2.14, Fig 3.3, Fig 3.5 sprinkler irrigation, Fig 3.5 ridge and furrow, Fig 3.6, Fig 3.9, Fig 4.1, Fig 4.3, Fig 4.5, Fig 4.6 peas, Fig 4.7, broccoli, cabbage, cauliflower, Fig 4.8 potato, tomato, Fig 4.9 millet, maize, Fig 4.10 cucumber, water melon, pumpkin plant, Fig 4.15, Fig 4.16, Fig 1.7, Fig 4.31, Fig 4.33, Fig 5.8 lime, lemon , naartjie, orange, Fig 5.9 apricot, peach, pear, apple, Fig 5.10 supreme peach, golden peach, Fig 5.11 cavendish, lady finger, Fig 5.12 naval orange, Fig 6.3 fungi, fungal disease, Fig 6.4 bacteria, bacteria plant, Fig 6.5 virus, Table 6.3 rosette, maize streak virus, Fig 6.6, Fig 6.9 star grass , goose grass, Fig 6.10 black jack, thorn apple, Fig 6.13, Page 80 cow, Page 83 rabbit, Fig 8.1, Fig 8.2, Fig 8.18 chicken sausages, chicken thighs, Fig 9.10, Fig 9.12 post wooden fence, rail wooden fence, Fig 9.13, Fig 9.14, Fig 9.16, Table 9.2 tape measure, digging auger, axe, pick or mattock, shovel, hacksaw, pliers, claw hammer, Table 9.3 dumpy level, staff, tape measure, hammer, axe, bow saw, Fig 9.17 a and b, Fig 9.19

Wikimedia commons: Fig 1.8, Fig 2.1, Fig 2.2, Fig 2.4, Fig 2.7, Fig 2.8, Table 2.1 aloe vera, elephant, Fig 2.14 birds, Fig 3.1 sandy soil, Fig 3.5 center pivot Fig 3.7, Fig 4.5, Fig 4.6 beans, groundnuts, Fig 4.18, Fig 4.20, Fig 5.12 valencia orange, Table 6.1 late blight, downey mildew, grey leaf spot, Fig 6.4 bacteria plant, Table 6.2 bacterial blight, Fig 6.5 viral plant, Fig 6.7, Fig 6.8, Fig 6.10 witch weed, Fig 6.11 couch grass, rapoko grass, Fig 6.15, Page 82 hen, Fig 8.7, Table 8.10 fowl tick, red mite, lice, fleas, scaly leg mite, Table 8.11 tape worm, gape worm, roundworm, Fig 9.21

Dreamstime: Fig 1.5, Table 2.1 pangolin, Table 3.1 loam soil, clay soil, Fig 8.3 indian river, cobb, ross, Fig 8.10 flea, Table 9.2 digging bar, wheel barrow, bow saw, wire strainer, Table 9.3 gunter chain

Shutterstock: Fig 3.8, Fig 5.14, Fig 8.18 chicken patties, Fig 9.10

Masimba Madondo: Fig 3, 6, Table 6.2 black rot, Fig 9.11, Fig 9.15, Fig 10.2

Zinengeya Danson: Fig 2.6, Fig 4.30, Fig 4.21, Fig 4.32, Fig 5.15, Fig 6.12 oxalis, lantana camara, Fig 6.14, Fig 6.16, Fig 8.6, Fig 8.12, Fig 8.13 Fig 8.14, Fig 8.15

Briggs irrigation: Fig 1.11

Karl Ax: Fig 5.13

FAO Swalim United Nations: Fig 1.7

Central Statistics Office (Zimbabwe): Fig 1.1

Contents

CPS

Secondary

Agriculture 2

New Curriculum

Learner's book

CHAPTER 1 General agriculture -Land use

Chapter objectives

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

- explain the effects of population on land use
- describe different farming systems
- describe ways of reducing effects of environmental factors on agricultural activities

Key concepts

- Population growth and land use
- Farming systems
- Modification of adverse environmental factors

Introduction

Agriculture plays an important role in human life. Agricultural products provide the basic human requirements which are food and cloth. Zimbabwe's economy is mainly sustained by agriculture. Agriculture is the growing of crops and rearing of animals for family consumption or for commercial purposes. It involves the knowledge of manipulating natural resources, use of science, use of technology as well as application of agronomic, scientific and economic principles in production management. Agriculture can be practiced on a small or large scale.

Agricultural activities are carried out on the land which is the backbone of agriculture. Land is a natural resource that is limited as it does not expand with expansion of human population and subsequent expansion of human settlement areas. Expansion of settlement areas, industries and towns have not spared land for agriculture. Continuous expansion of human settlements reduces land available for agriculture. Human settlements and industries pollute water bodies reducing the quality of water for irrigation. Solutions to effects of population growth on land use need to be intensified. Farming systems need to match the need for more food production. This calls for sustainable and resilient farming practices.

Agriculture is practiced using many different systems of production. This chapter will discuss mixed farming, monoculture and intercropping as some of the farming systems practiced in agriculture. It is important that farmers understand the various farming systems so that they use the best system suitable to their environment and maximize production.

Environmental factors such as temperature, humidity and wind activities may influence land use forms in one way or the other. Farmers should know ways of managing these environmental factors to minimize their negative impact.

Forestry and wildlife management are forms of land use that play an important commercial and social role in society. Sound knowledge is required in establishing and managing plantation forests.

Farmers should be able to use wildlife (animals and plants in their natural environment) in a sustainable way. This involves protecting certain species and dealing with problem animals.

Land use forms in Zimbabwe

Land is used for various aspects of human life. Generally, land is used for agriculture and for settlement. Population or total number of people living in an area generally increases with time. This exerts some pressure on the land. Demand for land as a resource increases, and this may also influence the forms of land use. Agricultural land, which is land devoted for agricultural purposes is then used for other social and economic human needs.

Land in Zimbabwe is used for various activities such as farming, mining, forestry, wildlife, recreation, industries, roads and other infrastructure.

Population growth and land use

Population is defined as the total number of humans or organisms occupying an area at any given time. Population increase refers to the increase in the number of people living in an area. Population growth or increase in numbers of people can be a result of more births or migration of people into an area. As human population or total number of settled people increases, more land is used to build homes, towns, industries, recreational parks and many other non-agricultural human activities. The use of land for settlements will take up land which is arable. Continuous expansion of population and settlements will continuously reduce the hectares of land available for farming activities.

Zimbabwe population density

Population density can be defined as the number of people occupying a specific size of an area. Zimbabwe's population density is 40.3% people per square kilometer. Density of population is calculated as permanently settled population of Zimbabwe divided by the total area of the country. The total area is the sum of land and water within international boundaries of Zimbabwe. The total area of Zimbabwe is 390 760km^2 according to the United Nation Statistics division. Population density is calculated as:

$$\frac{\text{Total number of people}}{\text{Area (km}^2\text{)}}$$

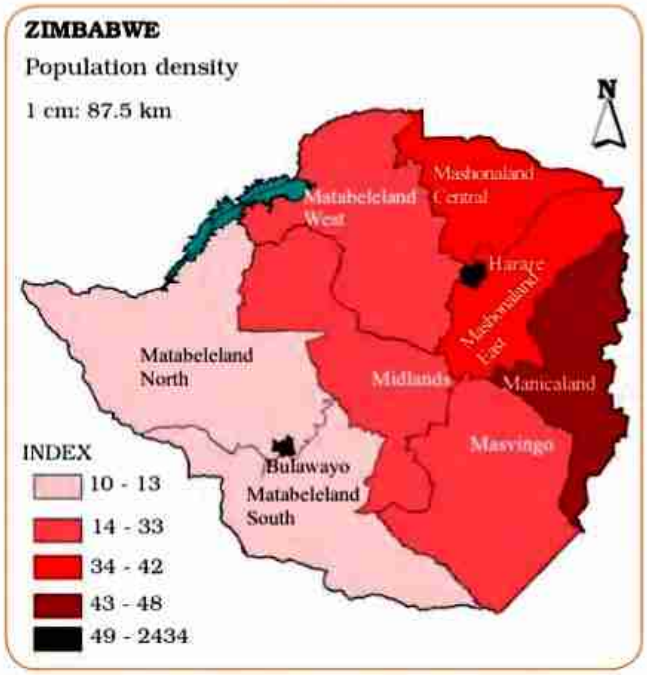


Fig.1.1 Zimbabwe's population density per province (2012 Central Statistics Office)

Effects of population growth on land use

Pressure on resources: Population growth results in increased need for use of resources such as roads, schools, clinics and hospitals. There is a resultant pressure increase on natural resources such as firewood. This leads to high levels of deforestation, leaving the soil bare and more prone to soil erosion. The land may end up degraded or useless for agriculture.

Demand for agricultural land: Due to increased population density, family land holdings are reduced to smaller units as a result of subdivision of land to younger generations. Each created family unit will have smaller subdivision units with less cropping land. When family units have small land holdings, food production levels are reduced, eventually leading to hunger and starvation.

Pressure on grazing land and animal productivity: Reduced grazing area for livestock will mean an area will have a limited number of livestock it can sustain without injury to the environment. If overstocking occurs, it results in reduced livestock productivity. The available feed will not be able to sustain the livestock and in high animal population densities, spread of diseases is quick to devastating levels.

Demand for residential places: Due to increase in population and creation of new families, there is increased demand for land to build homes and social facilities such as parks, sporting facilities, industries and commercial business areas. This will take up potential land for agriculture and some farms leading to reduced cropping and grazing land.

Degradation of the environment: Environmental degradation or destruction of the natural surroundings will result from overuse of some natural resources to levels that impact negatively on environment. Intensified agricultural activities are carried out in areas with limited space due to high demand for land. In intensified systems, there is high productivity over a small area achieved by use of mechanization and chemicals. This leads to high levels of pollution of the environment. For example, chemicals and fertilizers from agricultural activities are washed into streams and finally into rivers and dams, and untreated industrial and sewerage wastes may find their way into streams, rivers and dams.

High levels of nutrients from fertilizers washed from the cropping land build up in water bodies to levels that promote over growth of some microscopic plants that live in water. These microscopic plants grow to the extent of blocking irrigation canals, and increasing demand for oxygen in the water thus disadvantaging water living animals such as fish.

Industrial fumes contain gases such as sulphur and carbon dioxide. Sulphur combines with rain drops in the atmosphere to form a weak or mild form of sulphuric acid, the resulting acidic rain drops fall as acid rain. Acid rain will destroy plants and disturb their proliferation, resulting in high levels of erosion due to reduced organic soil cover. Carbon dioxide levels in the atmosphere increase due to fumes from industries and vehicles in cities and

tobacco curing processes in farms. A build up in carbon dioxide levels in the atmosphere results in an abnormal environmental temperature increase, a phenomenon known as global warming.

The combined effects of wrong agricultural practices, industrial wastes and gases, domestic wastes, result in a negative environmental change. The land becomes degraded or poor to sustain life.

Destruction of forests by human for settlements and agriculture and by acid rains results in reduced evapotranspiration. Reduced evapotranspiration levels lead to subsequent low amounts of rainfall and poor plant growth. The land becomes very poor to sustain plant and animal life as the soils will be poor, eroded with less organic matter. Reduced rainfall amounts are received as a result of the climate change caused by loss of vegetation.

Activity 1.1

Discussion on population effects on land use

1. Discuss the changes in land uses that have been witnessed in your local community as a result of population growth.
2. Establish and discuss the effects of population growth on agricultural activities in your local community.
3. Using text books, cellphones or computers connected to the internet, establish the meanings of the following terms and discuss suggestions on how each would affect land use.
   a) overpopulation
   b) underpopulation
   c) optimal population

Activity 1.2

Educational tour

1. Organize and carry out an educational tour to a nearest farm.
2. Identify the types of farming activities carried out at the farm.
3. If the farm is a crop farm, establish field sizes, plant spacings and calculate plant population density of selected crop fields with the assistance of a farm personnel and facilitators. Write brief notes on how you will come up with the plant population density.
4. If the farm is for animals, calculate the animal population density on that farm. Choose one specific type of animal. Write brief notes on how you will come up with the animal population density.

Solution to problems of population growth

Family planning awareness: One of the best ways to control population growth is by making people aware of the need for family planning, its advantages and details of available birth control methods. This can be done through public shows by relevant health authorities, community based health workers and public media adverts on television, phones, newspapers and billboards. Organizations involved in population control include PSI (Population Services International) and Zimbabwe Family Planning Council (ZFPC) in conjunction with the Ministry of Health and Child Welfare. PSI provides contraceptives and carries out annual population surveys to monitor population growth. The ZFPC provides awareness to the public on available contraceptive methods and options that can be used in family planning. China is an example of one country that managed to control its population through its one child per family policy in the 1960s.

Environment awareness campaign: The public should be made aware of the importance of a clean natural environment and the need for sound sustainable environmental management. Government departments, schools and authorities should educate people on the effects of pollution and encourage safe deposition of waste materials. Farmers should be encouraged to adopt better methods of farming by extension workers from the ministry of agriculture.

Awareness campaigns will help the citizens to use resources wisely in a way that promotes use of the resources over generations without the resources losing quality and remaining natural. The impact of population pressure due to population growth is therefore minimized. In Zimbabwe, we have EMA (Environmental Management Agency) established to prevent environmental degradation, pollution of environment and promote sustainable environmental management. It empowers citizens with knowledge and skills to manage the environment. EMA places posters and stickers that encourage cleaner environment and recycling bins placed in strategic positions in public places. Some funeral parlours in Zimbabwe carryout awareness campaigns in support of protecting the environment. They provide tree seedlings at funerals as a service to mourners for them to plant in memory of their deceased, thereby indirectly promoting reforestration.In addition, banning vehicles on the road reduces emmisson of carborn dioxide.

Technological advances: Use of electricity and environmental friendly high technology production equipment and improved farming methods will reduce environmental degradation. Because of technological advances, Zimbabwe is moving towards paperless offices.

Use of alternative energy sources to wood would greatly reduce the number of trees cut down for firewood. In rural areas people are fined by chiefs and headmen for cutting down trees as a way of protecting the environment. Less carbon dioxide will be produced from cooking activities.

There is also need for advanced technology that treats industrial and vehicle fumes to harmless wastes to the environment. Vehicles can be fitted with catalytic converters to reduce release of toxic substances into the environment. There are carbon taxes fixed by EMA on people who surpass permitted carbon dioxide pollutant levels.

Use of environmentally friendly technology helps to reduce damage to the environment as the human population increases. Efficient technologies will result in sustainable use of natural resources and human activities will have a less negative effect on the environment.

Establishment of social facilities: Schools, universities, social welfare funds and availability of inclusive social infrastructure will help to slow down population growth as the sexually active generations will be occupied to some extent in their studies and carrier specialization areas. Empowering school leavers to create jobs is beneficial to population growth control. This will help to occupy and create a focused generation.

Activity 1.3

Establishing and calculating population densities

1. In groups, share your understanding of the term population density and come up with a common definition to the term.
2. Calculate the population density for a ward in Manicaland which covers 20 square kilometres and occupied with a population of 150 people.
3. Visit the school garden and calculate population density of plants in a vegetable bed with calculated and known space area.

Farming systems

Farming systems are the ways in which production is carried out on a farm as a unit. A farmer can grow a single crop on the entire farm, can grow mixed crops in the same field and can divide the farm into units or divisions for livestock production and crop production, all depending on the farming system the farmer wants to follow. The farming systems that will be discussed in this section of the chapter are mixed farming, monoculture and intercropping.

Mixed farming

Mixed farming is a farming system which involves the rearing of animals and growing of crops on the same farm. The farm is partitioned to cater for efficient plant and livestock production. The farm will have different crop and livestock enterprises. An enterprise is a single unit of business that adds up to the sum total of whole farm production. Examples of crop enterprises include choices of different crops grown. Livestock enterprises will include the animals or livestock types on the farm.

An example of a typical mixed farm with different enterprises is that of a farm raising broilers, dairy cattle, growing tobacco and wheat. The farm is said to have a broiler enterprise, dairy enterprise, tobacco enterprise and wheat enterprise. The individual crop or livestock production activity accounting is done separately so as to asses profitability.

The farm infrastructure should enable production of livestock animals to be carried out without interfering with cropping activities.

The illustration below shows a set up or layout of a mixed farm.

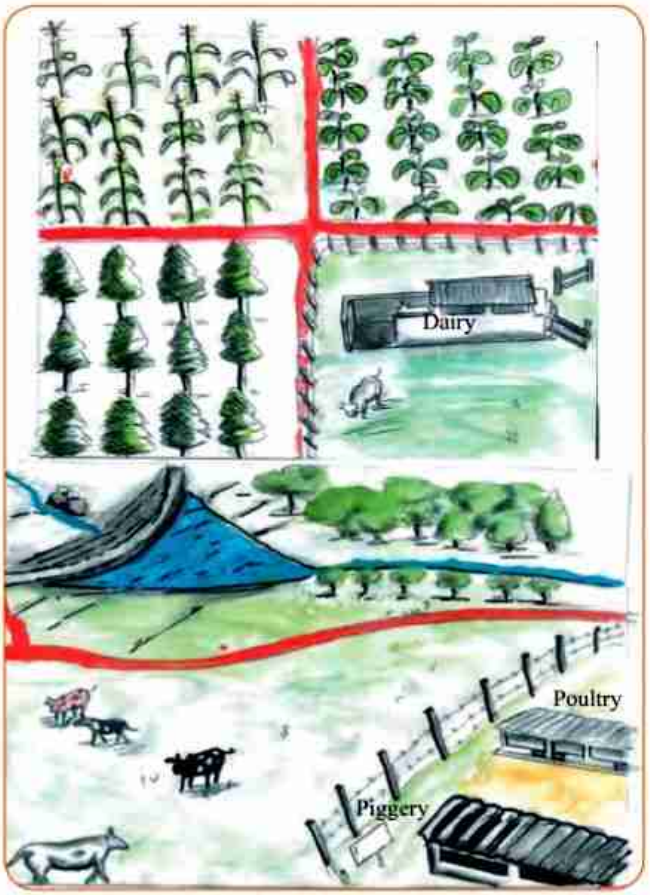


Fig. 1.2 Layout of a mixed farm

Advantages of mixed farming

- There is little wastage and value addition when crop residues are fed to farm animals.
- Manure from livestock is applied to cropping land.
- A more stable income base is created as income is earned from both animals and crops than relying on one enterprise that may be affected by bad weather or natural hazards resulting in reduced financial income for the farmer.
- More diversified (different types) food is produced leading to a balanced and improved nutrition.
- Mixed farming allows spreading of risks or reducing the impact of unforeseen hazards that results in production losses. The farmer does not have to rely on one enterprise or area of production for income. Disasters or natural hazards such as droughts may affect some crops or livestock, so if a farmer is growing different types of crops and rearing different types of livestock, not all the crops and livestock may suffer the impact of the disasters and the farmer will rely on those enterprises that survive.

Disadvantages of mixed farming

- It is labour intensive. This means it requires more and skilled labour.
- More capital is needed to invest in production infrastructure and specialized equipment for different enterprises.
- It requires more land for different agricultural activities.
- It requires methodical, scientific and proper management.

Monoculture

Monoculture is the practice of growing the same crop on the same piece of land for several years until the plants have lost productivity and are then replaced. Monoculture is mainly practiced in plantation tree crops for timber, fruits and sugar cane. Plantation fruit crops include **citrus** fruits, macadamia nuts, apples, peach and banana. The plant will occupy the same piece of land during production for several years, being managed by pruning, irrigation, fertilizer application, weeding, disease and pest control to lengthen productive years of the plantation trees. The picture below shows plantation tree crop in a monoculture farming system.

Fig. 1.3 A banana plantation

Advantages of monoculture

- Supplies crops on high and constant demand.
- Works well under limited land use in small holder farmers.

Disadvantages of monoculture

- Leads to high levels of pest and disease build-up which may be difficult to control and eradicate.
- High risks of income losses, if a natural disaster occurs.
- The same nutrients are exploited to depletion levels by the established plants and some nutrients not required by the plants are never used.
- May weaken the soil and lead to soil erosion if land is occupied by plants with little leaf foliage.

Intercropping

Intercropping involves the growing or planting of more than one crop at the same time on the same piece of land. A farmer can grow field beans and maize at the same time in the same field as an intercrop.

Fig. 1.4 Intercropped maize and bean field

Advantages of intercropping

- Reduces risk of total failure in the event of a natural disaster. One crop may survive the disaster and the farmer will have to rely on it for food or income.
- Reduces soil erosion through provision of ground cover when cover crops with broad leaves such as pumpkin varieties and water melons are included in the intercrop.
- Provides an improved diet to farmers due to production of many types of crops with different nutritional values.
- Intercropping produces high total yields per unit area.
- Reduces the spread of diseases if a beneficial combination is established.
- Pollination is enhanced as beneficial insects are attracted by presence of assorted choice of flowering structures from the different mixed crops.
- Enhances uniform utilization of nutrients by different crops that differ in their nutritional requirements and rooting structure. Shallow rooted crops will use near surface nutrients and the deep-rooted crops will use nutrient from deeper soil levels.
- Pest build up is reduced as some plants may chase away pests for the other crop in the intercrop establishment.

Disadvantages of intercropping

- Some crops may not be compatible, resulting in reduced productivity.
- Can be expensive as specialized equipment may be required for the different crops.
- Bushy crops may harbour pests that may affect the other crop in the intercrop.
- Some crops may have different nutritional requirements which might be expensive for the farmer.
- Intercropping may pause problems with selective herbicides use as crops may be of different families and one of the crop may be affected by the herbicide.

Activity 1.4

Survey on local farming systems

1. Assess the agricultural practice done in your home area and identify the farming systems being practiced by farmers.
2. Establish the productive levels, whether it is for consumption, small scale or commercial large scale.
3. Suggest other agricultural projects or enterprises suitable for the area.

Activity 1.5

Educational tour

1. Visit local farms and farmers that practice mixed farming, mono-cropping and intercropping.
2. Collect as much information through observations and interviewing the farmers.

Environmental factors influencing agriculture

Climatic factors

As part of the crop and livestock production environment in agriculture, climatic factors such as rainfall, humidity, temperature, hail and wind have significant influence on agricultural activities in their extreme conditions. The various effects of extreme climatic conditions can be combated by a number of ways that can be practiced in order to minimize the negative effects on production.

Effects of climatic factors

Rainfall

Rainfall which falls or precipitates in the form of hail, water droplets and mist is the most influential climatic factor on agricultural activities. The distribution patterns of the rainfall throughout the rain season, the total amount and frequency of rainfall can dictate the agricultural activities that can be carried out in an area.

High rainfall

High rainfall areas have less limits to agricultural activities that can be carried out in the area. Intensive livestock and crop production can be carried out in such high and reliable rainfall areas.

Excessive rainfall, however, may result in flush floods which may be very destructive to crops and livestock.

Fig. 1.5 Devastating effects of floods

Hailstorm

When temperatures at condensation (cloud formation level) levels are very low, condensed water droplets in the clouds freeze and fall as hailstones or frozen water. The hailstones fall at very high velocity or speed, and shred plant leaves. Hailstones may also kill small livestock.

Fig. 1.6 Maize crops destroyed by hailstorm

Low rainfall

Areas receiving low rainfall will have to grow drought tolerant crops and practice extensive cattle ranching. Crop production is carried out under irrigation to augment rainfall shortages.

Absence of rainfall or very little erratic rainfall results in drought conditions that cause death of plants, animals and sometimes humans die from hunger. Total crop failure may result.

Fig. 1.7 Animals affected by drought

Humidity

Humidity is the amount of water vapor in the atmosphere at any given time.

High humidity

When air is saturated with moisture or vapor the air is said to be humid. Under such high humid conditions, transpiration and evaporation losses are low. High humidity levels in hot environments favor development of fungal disease which may wipe out crops.

Fig.1.8 Pumpkin crop affected by fungal diseases

Low humidity

Extremely low humidity conditions result in the air being dry or less moist. Under low humidity, plants lose more water through transpiration and evaporation. As a result, losses from the soil will also be very high. Plants lose a lot of water and if soil moisture is not adequate, the plant wilts, meaning it loses its firmness or upright standing ability.

Temperature

This is the measure of degree of hotness or coldness. The temperature of the atmosphere directly influences the temperature of living and non-living matter. Optimum temperatures or best suitable temperatures vary for organisms. However, extremes of temperatures negatively affect crop and livestock production.

High temperatures

High temperatures of above 40°C are harmful to plants and livestock. Livestock suffer and die from heat stroke under extremely high temperatures. Poultry birds such as broilers are most affected.

Under high temperature, protein material in tissues of organisms is destroyed making some tissue and organs to malfunction, and eventually leading to the death of the organism.

Plants wilt and may die if moisture is not made available under prolonged periods of subjection to high temperatures.

Fig.1.9 Wilted plants from high temperatures

Low temperatures

Low temperatures of below 5°C can be very disruptive to agricultural production. Seed germination is slower under low temperatures and some seeds may fail to germinate.

Freezing temperatures burn and kill plants and this is known as frost bite. Plants are destroyed when water in plant cells freeze and expand, rupturing cell walls.

Young ones of animals are killed by low temperatures as they will not have developed adaptive mechanisms to survive extreme climatic conditions.

Animal mobility is reduced by low temperatures. This results in low breeding rates and reduced animal productivity.

Egg production is reduced under low temperature conditions.

Fig. 1.10 Frost bitten plant

Wind

Wind is air in motion. Air moving at high speeds exerts a lot of force on crops and livestock. Strong winds destroy crops, cause flower-drop, fruit-drop and cause lodging in some susceptible crops. This may significantly reduce yields or result in no yields at all. However, gentle wind is beneficial for pollination in agricultural crops.

Ways of reducing effects of environmental factors on agricultural activities

Farmers can carry out certain practices to combat or reduce the negative effects of extreme environmental or climatic conditions. Practices such as irrigating, mulching, manuring and shading are some of the practices that can be used by farmers in managing negative environmental effects on agricultural production. Livestock will need special provisions to manage effects of climatic factors such as temperature and rainfall.

Ways of managing effects of extreme rainfall

High rainfall may cause flash flooding which may destroy crops and livestock. Farmers in low lying areas should avoid settling and carrying out farming activities as low lying areas are prone to flooding. An example of such areas prone to flooding is the Muzarabani area in Zimbabwe.

Dam construction helps to collect flood waters and this reduces the effects of flood waters as the water is contained in dams. Dams also help to combat drought effects, since water collected in dams can be used for irrigation and livestock when rainfall amounts are insufficient for farming.

Hailstorm

In hailstorm prone areas, farmers should carry out practices that are not affected by hailstorm, such as, production of housed small livestock like broilers which are reared in protected housed environment.

In hailstorm prone areas, farmers should avoid growing leaf crops (plant whose value is in the leaf) and grow plants less affected by hailstorm such as forest trees.

Managing low rainfall conditions

Tied ridging

- Here crops are planted on ridges. The adjacent ridges are joined. The tied-ridges allow water to settle in ponds and infiltrate. It also reduces surface run-off, thereby reducing soil erosion.
- Tied ridges should be lower than the ridges otherwise the ridges will break when the ponds are full.

Fig. 1.11 Tied ridges

Water harvesting

- Water is harvested during the rainy season to help prolong the wet periods by irrigating crops.
- Water is harvested through gutters, tanks and dam constructions.
- Schools can also construct affordable but durable tanks to store water as shown in Figure 1.12.

Fig. 1.12 Water harvesting through tank and gutter

Pot holes

- Pot holes are small holes dug randomly in the field between crop rows.
- These small holes collect water from surface run-off and as rain drops.
- Pot holes allow water to infiltrate and keep moisture for a long time.

Ways of managing extreme high and low temperatures

Managing low temperature effects

Addition of manure

Effects of low temperatures can be managed by adding manure to the soil to raise soil temperature. Mulching or placing of grasses and plant remains help to keep the soil warm.

Irrigating

Frost usually destroys crops in the very early hours of the morning. It is advisable for farmers to irrigate or sprinkle the crop with water at night so as to protect the crops from frost injury.

Small fires

Small fires can be lit around crop fields to raise the temperature of the field area during periods when frost is most likely to occur.

Artificial heat sources

In livestock units, heating facilities can be placed in animal units to provide warm temperatures. Warmth can be provided by electric heaters, charcoal heaters or kerosene heaters.

Greenhouses

Greenhouses are commonly used where temperatures are low. They trap heat and make the environment warm. Some greenhouses can be fitted with electric climate control gadgets used to maintain desired temperatures.

Fig. 1.13 A greenhouse

Managing high temperature effects

Mulching

To prevent plant wilting because of high moisture losses from high temperatures, farmers can irrigate their crops to supply moisture and to cool the plant as well as the soil.

Mulching, which is placing of a reasonably thick layer (50mm thick) of organic matter like grass, leaves, compost and plant remains as soil cover, helps to provide shed to the soil from the scorching sun's heat.

Mulching helps in the following ways:

- It keeps the soil cool during hot weather.
- It saves water by reducing evaporation from the soil.
- It prevents the soil from being washed away in storms.
- It prevents lower leaves and fruits from touching the soil and picking up soil borne diseases.
- It prevents the soil from capping and hardening.
- As it decomposes, the mulch makes its nutrients available to the plants via the soil.
- It keeps the soil moist and cool, providing conducive conditions for soil organisms to thrive.

Fig. 1.14 Mulched bed

Shading

Young nursery plants are also provided with shade from intense heat using commercial polythene material. This greatly reduces deaths of plants from high temperatures due to excessive moisture loss.

Fig. 1.15 Shaded nursery plants

Activity 1.6

Managing environmental conditions

1. Use grass and plant leaves as mulching to cover soil in crop beds.
2. Use polythene shades to cover crops and water the beds to reduce high temperature effects.
3. Observe how plants in mulched and shaded beds compare.

Ways of managing low and high humidity

High humidity

Humidity can be managed under controlled environments such as greenhouses. In greenhouses, electronic climate control gadgets such as air conditioners can be used to control humidity. Sulphur candles can be burnt in greenhouses when humid conditions are prevailing. This minimizes the risk of fungal disease development.

In cropping fields, planting patterns should allow free air circulation to reduce humid conditions.

Low humidity

If air is too dry in greenhouses and tobacco buns, humidifiers can be used to make the air more humid. When humidity levels are too low, dried tobacco leaves in buns may become brittle and shutter, resulting in losses. Humidifier blows a mist or fine air spray that softens the tobacco leaves and makes them less brittle for packaging. In the absence of humidifiers, knapsack sprayers can be used to spray water to humidify air.

Ways of managing strong winds

Fig. 1.16 A wind break

Farmers can grow wind breaks or tree lines to reduce wind speeds to levels that are less destructive to plants. Farmers can also carry out practices that are less affected by strong winds.

Activity 1.7

Visiting a greenhouse

1. Establish how greenhouse micro-climate is controlled and maintained.
2. Find out how extreme climatic conditions are managed in greenhouses.

Summary

- Population growth reduces land for farming activities such as cropping and grazing lands.
- Population growth results in increased demand for land required for settlement, commercial and social activities.
- High population densities as a result of population increase will lead to pressure on natural resources, deforestation and environmental degradation.
- Some human activities in growing settlements may produce gaseous pollutants that may result in micro or global change in climate.
- Population density refers to the number of organisms in a specific measurable area per given period of time.
- Waste management problems accompanied by population growth may result in pollution of water bodies. This lowers the quality of water for irrigation and livestock production.
- Use of clean efficient technology in human settlements and commercial activities can reduce the pollution impact of population growth on the land and environment.
- Mixed farming involves crop and livestock production on the same farm.
- Intercropping is the practice where different crops are planted together in the same field.
- Mono-cropping is practiced in plantations where a single crop occupies the same piece of land year after year.
- Environmental factors such as rainfall, temperature, humidity, hail and wind have a negative impact on agricultural activities, in their extreme conditions.
- Negative environmental effects can be managed by practices such as irrigation, mulching, shading and manuring.

Glossary

Land use:	land use involves the management and modification of natural environment or wilderness into built environment such as settlements, arable lands/fields, plantation forests, pastures and wildlife reserves
Population:	population is a group of people or animals in a specific geographical location
Community:	a community is a social unit that shares common values and resources and occupies a given geographical space such as village or town
Agricultural land:	this is land devoted to agricultural activities such as rearing of livestock and production of crops
Population density:	is the number of species or people per unit area per given time
Degradation:	loss of quality and usefulness
Diversified crops:	various forms of plants
Risk:	unforeseen hazards that can result in economic losses
Citrus fruits:	family of fruits such as oranges, limes, naartjie and lemons
Deforestation:	loss of forest trees due to uncontrolled cutting down of trees
Frost bite:	damage to living organisms by freezing temperatures

End of chapter questions

1. The total number of people living in an area is known as…
   A. density B. population C. number D. total
2. Population growth can be controlled by which of the following methods?
   A. family planning awareness campaigns
   B. killing new born babies
   C. prohibiting marriages
   D. control
3. Construction of more housing units results in…
   A. increased cropping land
   B. reduced cropping land
   C. no change in land usage and available agricultural land
   D. better urban cropping
4. What is involved in mixed farming system?
   A. growing different crops mixed together
   B. intercropping of crops
   C. rearing of livestock and crop production on the same farm
   D. rearing many different livestock
5. Select a list with effects of population increase on land use.
   A. reduced land size, pollution, land degradation
   B. land degradation, afforestation, pollution
   C. deforestation, pollution, afforestation
   D. reduced land size, pollution, farming
6. Define the following terms
   a) population (1)
   b) population density (1)
7. State the effects of population growth on land use and suggest solutions to resulting problems. (7)
8. What are the effects of population growth on farming activities and the farming environment? (4)
9. Explain the advantages of intercropping. (5)
10. Describe mixed farming system. (3)
11. What are the advantages of mulching crops? (4)
12. Describe ways used to reduce the impact of low rainfall on crops and livestock. (6)
13. Calculate the population density for 10 000 people living in an area measuring 10km^2. (3)
14. Discuss the effects of climatic factors to agriculture. (5)
15. Differentiate mixed farming from monoculture. (4)

CHAPTER 2 Forestry and wildlife

Chapter objectives

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

- distinguish between softwoods and hardwoods
- describe factors influencing choice of a nursery site
- establish tree seedlings in a nursery
- manage tree seedlings in a nursery
- establish tree plantations
- discuss the management practices of a tree plantation
- explain sustainable methods of wildlife utilization
- identify specially protected plants and animals in Zimbabwe
- identify dangerous and problem animals in Zimbabwe
- describe ways of dealing with dangerous and problem animals in Zimbabwe

Key concepts

- Softwood and hardwood
- Tree nursery
- Tree planting and management
- Sustainable utilization of wildlife resources
- Specially protected plants and animals
- Dangerous and problem animals

Introduction

Forestry and wildlife are forms of land use that are becoming very popular with indigenous farmers who have been allocated new farming areas. The growing of trees, managing them and harvesting ensures that tree resources are not over exploited. Forestry involves growing of local and exotic tree species. Wild life management involves managing wild animals and their environment in protected areas or game reserves by relevant authorities. Wildlife has lots of natural resources required by all human beings. It is everyone's responsibility to care for these resources. Wildlife studies focus on sustainable management and best use of natural resources

Forestry

Forestry involves the growing of tree crops, managing them and harvesting them profitably without negatively affecting the environment. Forests have a number of benefits to humans as they provide food, medicines, timber and shelter for animals. In Zimbabwe, there are natural forests with indigenous or local trees and exotic forest plantations with forest trees brought from other countries or regions with similar climatic conditions to Zimbabwe. Forestry production produces softwoods and hardwoods. It is important to be able to identify these trees and classify them into exotic, indigenous, softwoods and hardwoods to appreciate the value of each class.

Indigenous and exotic forest trees grown in Zimbabwe

Forest trees grown in Zimbabwe are divided into indigenous (local) and exotic (foreign) trees. Forest trees are further classified into hardwoods and softwoods. Hardwood trees produce dark coloured timber which is heavy, hard and tough. Softwoods usually produce timber which is light coloured, light weight and soft.

Indigenous trees in Zimbabwe

Many indigenous trees that have economic value and are harvestable are mostly hardwoods. Very few indigenous trees can be harvested with economic benefits as most are scattered and difficult to obtain meaningful harvests.

Indigenous tree species cannot be used on large scale commercial production as they take long to mature. Some may even take up to 100 years to reach maturity. The trees do not grow straight, making them less suitable for timber production.

Zimbawean hardwoods and softwoods

Zimbabwean hardwoods

These grow naturally mostly in sandy soils but their harvesting is managed and controlled by the forestry commission. The main hardwoods that are harvested for commercial production are Mukwa, Zimbabwean teak and mahogany. There are other indigenous hardwoods that are very nice but make insignificant commercial contribution. These include the blackwood, pod mahogany, msasa, among others.

Mukwa (bloodwood)

Fig. 2.1 Bloodwood tree

Mukwa hardwood grows well in sandy soils found in the middle and Highveld areas of Zimbabwe. The tree is common to member states in the southern part of Africa. Timber produced is hard with beautiful grains. It is mostly used to make veneer slices used as a finish to cheaper timber furniture to improve appearance.

Zimbabwean teak

Zimbabwean teak tree is found scattered in drier parts of the country and it produces reddish brown wood which is very tough and highly resistant to termites. It is used for making wooden floors.

Fig. 2.2 Zimbabwean teak tree

Fig. 2.3 Zimbabwean teak timber

Zimbabwean mahogany

Fig. 2.4 Mahogany tree

Mahogany tree produces hard and heavy timber used for furniture and wooden floors.

Fig. 2.5 Mahogany timber

Zimbabwean softwoods

Indigenous soft woods are insignificantly used for commercial purposes due to irregular growth patterns. However, indigenous softwoods play an important role in rural communities. Local softwoods are used for making cooking utensils, yokes, mortar and pestle. A number of soft woods exist scattered throughout Zimbabwe with some constituting an insignificant number in the forests such that no economic harvests can be made.

Fig. 2.6 Indigenous softwood

Exotic forest trees

These are forest trees brought from foreign lands with similar climatic conditions. The exotic trees are grown in managed plantation forests. Exotic trees grow straight and can reach astonishing heights in a short period of about 5 years. Most exotic trees mature in 6 to 10 years.

Exotic hardwoods

Most commonly grown exotic hardwoods in Zimbabwe are the *eucalyptus grandis* commonly referred to as saligna gum tree and the black wattle.

Saligna gum (*Eucalyptus grandis*)

Fig. 2.7 Saligna gum tree

These have fast growth and give light red coloured timber used to make furniture. Gum trees are mainly used for making poles that are treated with creosote for use in power transmission lines and communication cables.

Black wattle

The wattle tree is mostly grown in eastern highlands because the tree favors high rainfall and misty conditions prevalent in the eastern districts of Zimbabwe such as Nyanga and Chimanimani.

Most wattle plantations were managed by the Wattle Company of Zimbabwe and also by the settled farmers who ventured into forest tree production.

The wattle tree is grown for its bark which is harvested when trees have reached 10 years of maturity. The pine bark is processed and the extract from the bark is used in leather tanning industry.

Exotic softwoods

Most softwoods grown in Zimbabwe are from the southern parts of America where climatic conditions are similar to Zimbabwe. The most widely grown softwoods are from the coniferous tree species (corn bearing trees). Examples of softwoods grown in Zimbabwe are Mexican pine and slash pine.

Slash pine

Fig. 2.8 Slash pine

Activity 2.1

Identifying soft and hard wood timber species

1. List the types of hardwoods and softwoods that are grown locally.
2. Visit safe areas that are local and identify some of the softwoods and hardwoods.
3. Take note of the characteristics of each tree that you identify.
4. Find out the uses of the trees you have identified and how they are being conserved.

Tree nursery

A tree nursery is a place set aside for raising of seedlings or young plants before they are transplanted to their permanent planting positions. The site is usually protected with controlled entry into the nursery. The seedlings in the nursery are usually shaded and are given extra care until they adapt to the environment. The seedlings in a tree nursery can be raised in float trays, plastic pockets specially prepared with planting media (soil mixtures) and prepared beds on the ground.

Factors to consider when choosing a nursery site

When choosing a nursery site, a farmer has to make some considerations for suitable site.

- The suitable site should be free from termite and ant activity.
- Soils must be well drained and free from waterlogging.
- Areas that are prone to frost should be avoided.
- Doloritic soils are most suitable for tree nurseries.
- Site must be near a good and reliable water supply.
- The slope should be gentle to allow free drainage

Establishing a tree nursery

Forest trees can be raised from cuttings or seeds. Correct tree logging encourages shoots or coppices to develop. Tree seedlings can be sown mid-July to August. Although seeds can be sown directly in a nursery bed, it is encouraged to sow them in containers. Black polythene containers can be used but empty packs such as of sugar, rice, salt and cans can also be used as a way of recycling waste products. Seed rate is usually 1 kg per 1000 pockets for most trees.

- Most forest trees are established from seeds planted in polythene bags or kaylite trays. Polythene bags or trays are filled with specially prepared soil mixture or pine bark as planting media.
- The seed is sown to correct depth guided by a wooden tool. Small seeds such as gum tree seeds are picked using a nail head for sowing.
- The pockets sown with seeds are then watered and treated with Aldrin, an insecticide that prevents termite attack on seedlings.
- Pockets with newly sown seeds are covered with grass and watered with a can fitted with a fine rose.
- Seeds are watered regularly, but not oversupplying water.
- Germination is checked every day after 7 – 10 days from sowing.
- When seeds germinate, watering continues steadily. Over watering will cause damping off, a fungal disease that kills young plants (seedlings).
- Small seeded trees sown in trays are pricked or transplanted into polythene pockets until they reach the ideal size for planting.
- Root prune the seedlings to stop roots growing into the soil below the pocket. Root prune after watering to minimize damage to the plant.
- Hardening off, this is conditioning of the seedlings for field conditions. This is done by reducing watering frequency.
- Constantly check for pest and diseases.

Summary of steps in establishing a nursery

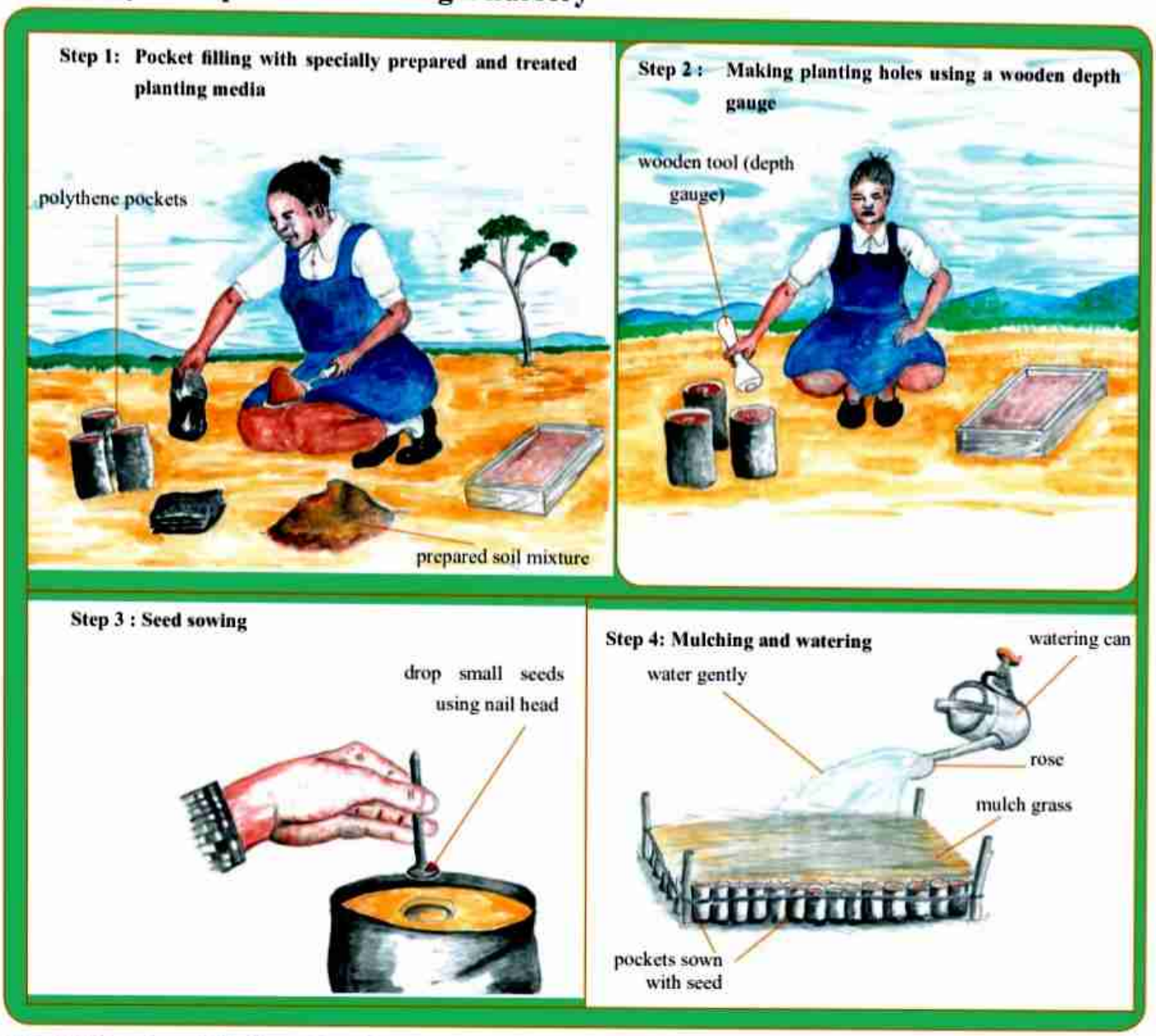


Fig. 2.9 Steps in establishing a forest tree nursery

Tree establishment and management

Seedling selection

Healthy disease-free seedlings should be used for establishing plantations. Seedlings should be planted when they are pencil thick and about 20cm to 30cm tall.

Site for planting

The site should have been prepared early by ploughing and stumping. A good site should have deep, fertile and well-drained soils. However, different trees require different conditions. Some trees such as the acacia can do well with little water and even infertile soils and are drought tolerant. Most exotic soft woods require more rain, cool to moderate temperatures and deep and fertile soils.

Tree plantation layout and seedling transplanting

- Most forest trees are spaced 2.5metres apart and the planting holes can be set in a number of layout patterns or methods. A spacing of 75cm to 100cm between rows and 25cm to 30cm between plants in rows is sometimes used where thin straight logs are required.
- Trees can be planted with other crops such as maize. In such a case, row spacing should be 3m to 10m wide and spacing between trees in rows should be about 2,5m to 5m. Rows of other plants can be grown between tree rows.
- The forest planting layouts include triangular, rectangular, hexagonal and the quincox layout.

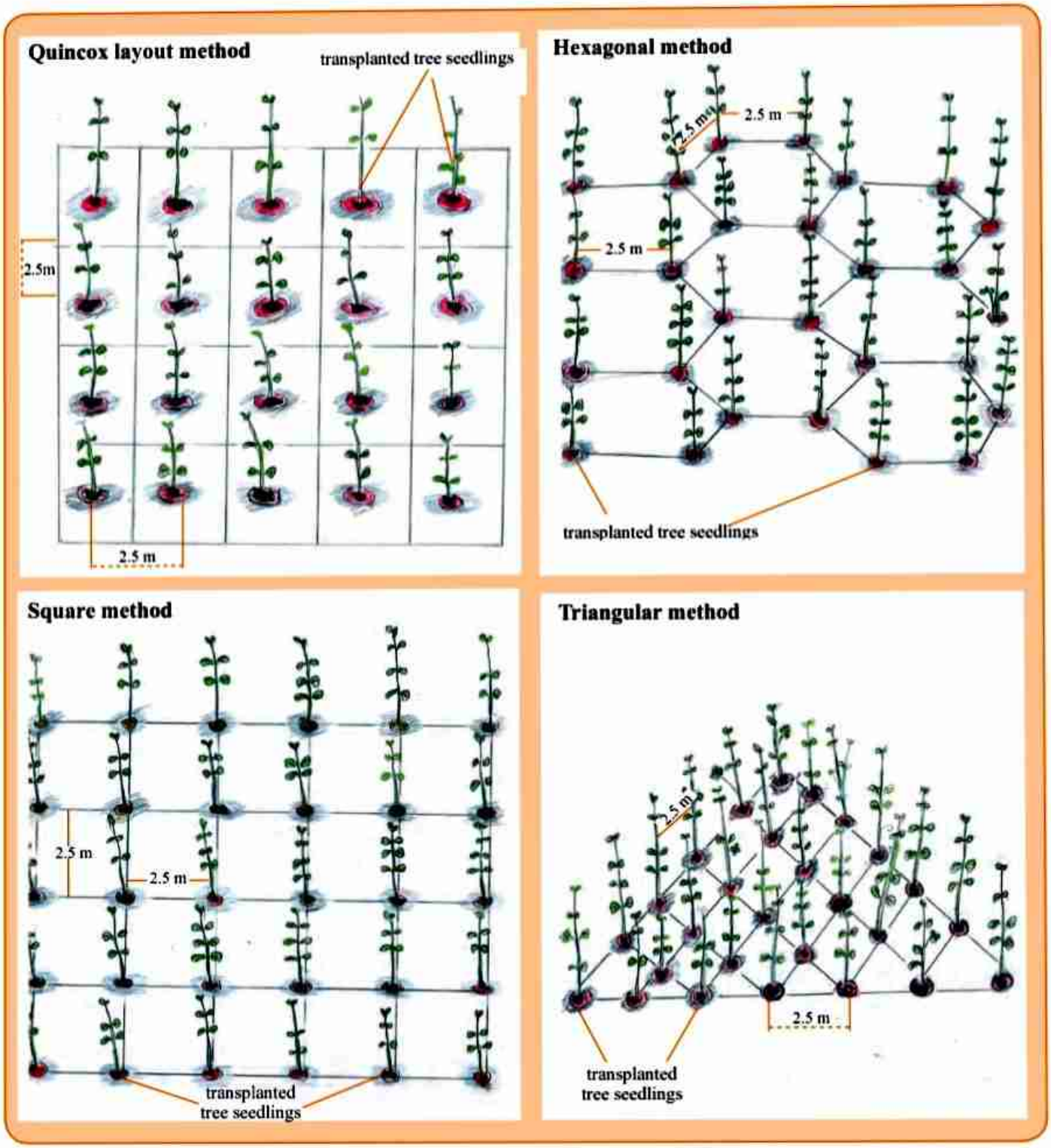


Fig. 2.10 Plantation layouts

Transplanting

Transplanting is the removal of seedlings from the nursery to their permanent planting stations. The seedlings should be well-watered at least an hour before they are pulled out.

Treat the seedlings with Aldrin against termite attack before planting. The polythene bag should be carefully removed with minimum damage to the roots, making sure soil on or around the roots remain intact.

Place the seedling gently in the planting hole and cover with soil. It is necessary to firm the soil around the planted tree by stamping with foot to exclude air pockets. Water the planted seedlings. Shading may be necessary if temperatures are too high.

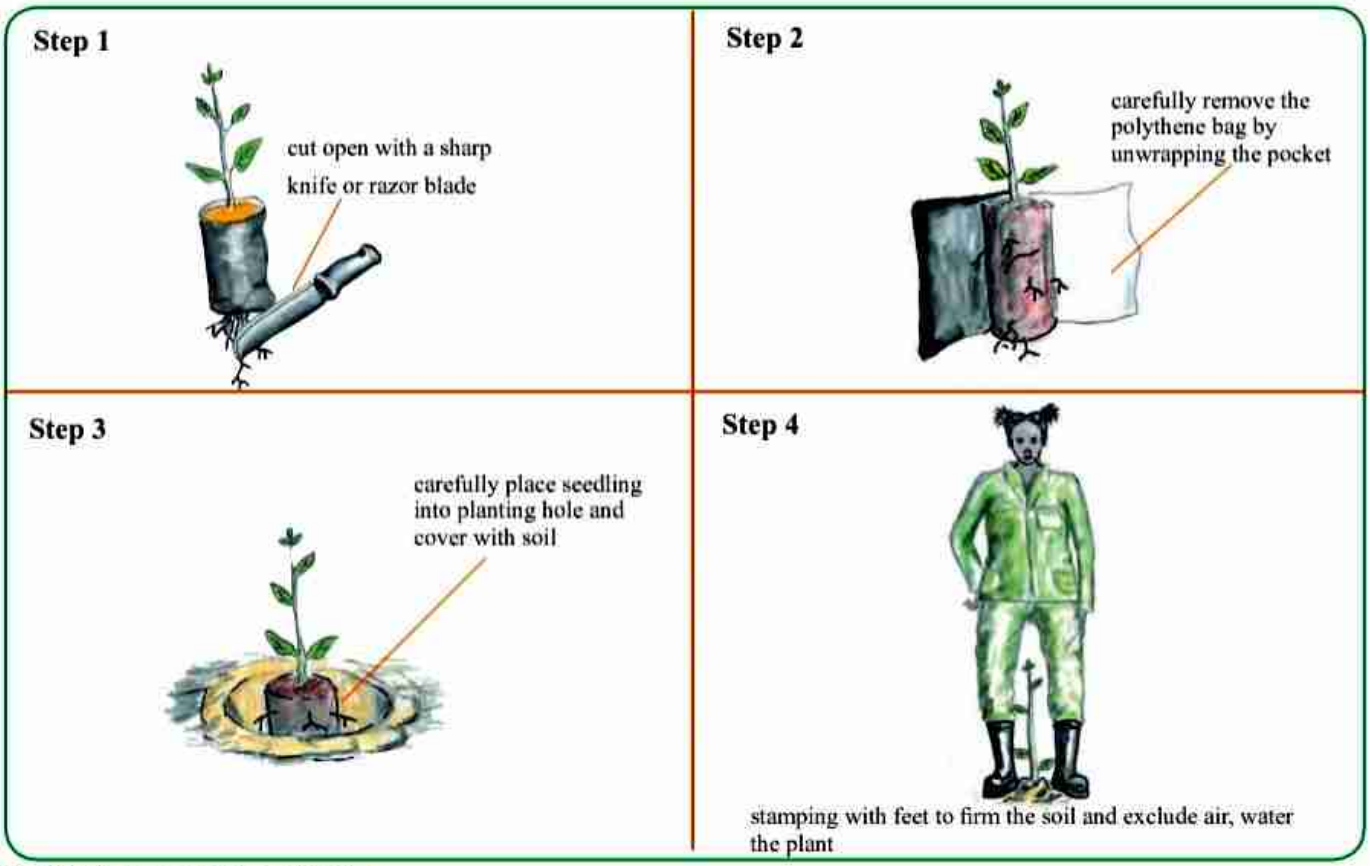


Fig. 2.11 Steps in transplanting

Tree plantation and management

- Established tree plantations are managed by protecting the plants from animals, harsh weather, weeds and diseases.
- Termite activities should be monitored and controlled.
- Fire guards or grass free bands around plantations should be made to protect trees from veld fires. Fire guards form a fire barrier.
- It is also necessary to prune and train the trees to grow straight during growth periods.

Activity 2.2

Establishing a tree nursery

1. Gather wild tree seeds and gum tree seeds.
2. Fill polythene pockets with rich fertile soil or use empty snack pockets.
3. Sow the collected seeds in the polythene bags at reasonable depth and water with can fitted with a rose.
4. Cover the pockets with grass to improve germination

Wildlife

Wildlife refers to wild animals and forests in their natural environment. The wildlife resources are important for scientific studies, medicines, provision of fruits and game meat. Wildlife plays an important role economically and socially. Wildlife also has an aesthetic value that attracts tourists from foreign countries, bringing into the country foreign currency.

Wildlife resources

Wildlife resources include wild animals, trees and soils. Humans hunt animals for meat, gather fruits from the wild and use leaves, barks and roots of certain trees to cure ailments. Wildlife management attempts to balance the needs of people using the best available science. This includes game keeping, conservation and pest control, controlled hunting and protected areas. With sustainable wildlife utilization, over-exploitation of resources should be avoided.

Sustainable utilization of wildlife resources

Sustainable utilization refers to the use of resources wisely in a manner that does not harm or affect the natural balance, quality of the resource and availability of the resource for next generations.

The use of resources can be consumptive which involves killing or harvesting the resources. Animals are killed for their products such as elephant tasks and dried meat processing. Killing of animals and harvesting of forest products should be monitored following set government policies and laws.

Non-consumptive use of resources includes activities such as game viewing, biological and ecological studies, bird watching and photography. These activities have little harm to the wildlife.

Traditional customs that help in sustainable utilization of wildlife

Traditionally, we used to have sustainable ways of using our local resources. Though most of them are no longer followed, some communities still respect the systems because they helped in both preservation and conservation of resources.

Traditional ways include:

- Use of animal totems - certain clans would not kill their totem animals.
- Some forest, mountains or rivers are regarded as sacred. These areas are not frequented by humans and are left in their natural state.
- Cutting trees or over-harvesting wild fruit trees is prohibited and monitored by traditional leaders.
- Animals regarded as sacred such as pangolin and python cannot be killed or eaten by the public. This helps to conserve the animal species.

These traditional values assured that wildlife resources were treated with care to satisfy the present generations as well as the generations to come.

Endangered plant and animal species

Endangered species are those organisms whose number will have dropped down to near levels of disappearing completely and are labeled for protection by law. These animals are kept in enclosures for assisted breeding and protection. Examples of endangered species in Zimbabwe include the rhinoceros, pangolin, leopard, cheetah, fish eagle and python, amongst others.

Some examples of plant enlisted as endangered include the flame lily, aloe, sabi star and mangrove fern.

Table 2.1 Some endangered plant and animal species

Plants	
• Flame lily 	• Aloe 
Animals	
• Pangolin 	• Python 

Animals	
• Elephant 	
• Rhinoceros 	• Cheetah 

Activity 2.3

Watching a documentary on Zimbabwe's protected plants and animals

1. Using cellphones, tablets or computers connected to the internet go to the start menu and click on the browser.
2. Type your key search words such as "documentary video of protected wild animals in Zimbabwe" on the dialogue box.
3. Many video options will pop up on the screen and you can select the best video options.
4. Projectors can be used to beam the video for the class.
5. If you do not have internet facility or library books, make use of your local elders or department of wildlife to give you information on this.

Fig. 2.12 Some dangerous animals

Management of dangerous and problem animals

Dangerous animals

Dangerous animals are wild animals that cause harm to livestock and humans. These include lions, hyena, leopard, king cobra snake, buffalo, rhino and hippopotamus.

Ways of dealing with dangerous animals

These are put in high security enclosures where feed and care is provided to prevent the animals from encountering people from local communities.

- The department of wildlife assists by controlling these animals through fencing to keep these animals away from homesteads and through provision of game reserves or protected areas.
- Some dangerous animals such as elephants and stray lions are killed or captured by wildlife authorities.

Problem animals

Problem animals destroy crops and disturb livestock. Problem animals include quelea birds, baboons, elephants, buffaloes, warthogs, spotted hyena, black backed jackal and wild or hunting dog. Jackals may kill livestock and spread rabies.

Fig. 2.13 Problem animals

Ways of dealing with problem animals

- The problem animals can be harvested by killing as a way of managing them.
- Fencing can be done to keep the animals away from human settlements.
- Scarecrows can be put to scare baboons and some birds.

Fig. 2.14 Scarecrows to keep some problem animals away

Activity 2.4

Video and discussion on dangerous and problem animal

1. Watch a TV channel such as national geographic and internet documentaries on wild animals from sites such as *http/www.youtube.com* or discuss with your local elders if you do not have internet facilities.
2. Discuss the effects of dangerous and problem animals found in your local community.
3. Suggest methods of managing the animals.

Activity 2.5

Tour of game reserves or zoos

1. Visit nearest game reserves or nearest zoos.
2. Identify animals found in the visited areas and classify them as protected, dangerous and problem animals.

Summary

- Forestry is a form of land use that involves management of forest trees and their harvesting.
- Indigenous hardwoods are not used on a large scale because they exist scattered and do not grow straight.
- Indigenous forest trees are mostly hardwoods such as mukwa, teak and mahogany.
- Exotic softwood trees grown in Zimbabwe are mostly coniferous or pine trees.
- The most commonly grown exotic hardwood is saligna gum tree.
- A nursery is a specially protected area for raising seedlings.
- Transplanting is the process of pulling out seedlings from the nursery to permanent planting station.
- Wildlife resources include trees, animals and soils.
- Endangered species are animals or plants with reduced numbers to near extinction levels.
- Some endangered species in Zimbabwe include rhino, pangolin, lion and flame lily.
- Problem and dangerous animals destroy crops and livestock.

Glossary

Forestry:	is the science and art of growing, managing and caring for forests
Softwood:	is the wood from a conifer (such as pine, fir or spruce)
Hardwood:	is the wood from a broad leaved tree (such as mukwa, teak and mahogany)
Wildlife:	refers to undomesticated animal species in their natural environment
Sustainable:	able to be maintained at a certain rate
Dangerous animals:	these are animals that are able or likely to hurt or harm human beings
Problem animals:	these are damage causing animals such as baboons
Zoo:	facility where some wild animals are kept in cages or fenced areas
Doloritic soils:	soils that are alkaline
Browser:	an application on electronic gadgets used to get to the internet
Dialogue box:	a box on the screen of electronic gadgets where instructions or commands can be typed

End of chapter questions

1. Which of the following is an exotic hardwood grown in Zimbabwe?
   A. mukwa
   B. saligna
   C. pine
   D. bloodwood
2. Indigenous hardwoods have a problem of…
   A. growing straight
   B. being very expensive
   C. taking long to mature
   D. maturing early before they are strong.
3. Select a pair with endangered plant and animal.
   A. flame lily; rhino
   B. flame lily; hawk
   C. flame lily; quelea birds
   D. rhino; elephant

4. Problem animals:
   A. eat human beings
   B. destroy crops
   C. kill all animals
   D. scream
5. What is the purpose of a fire guard?
   A. to maintain fire
   B. to create fires
   C. to prevent spread of fires
   D. for preventing termites
6. Define the following terms:
   a) Forestry [1]
   b) Wildlife [2]
7. List any 3 softwood and any 3 hardwood trees. [6]
8. Distinguish between softwoods and hardwoods. [2]
9. What is sustainable resource utilization? [2]
10. What is the difference between consumptive and non-consumptive use of wildlife? [2]
11. What sustainable ways can you use to conserve resources in your area? [2]
12. a) Define pricking out [2]
    b) Under what circumstances is pricking out done? [2]
13. Name any 2 problem and 2 dangerous animals. [4]
14. Define transplanting. [2]
15. Outline the factors that can be considered when selecting a suitable nursery site. [4]

CHAPTER 3 Soil and water

Chapter objectives

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

- describe soil profile with the aid of a diagram
- describe soil profile horizons
- describe the specification of each soil horizon to crop growth
- explain the importance of soil profile
- distinguish between organic and inorganic fertilizers
- describe types of organic and inorganic fertilizers
- differentiate compound from straight fertilizers
- discuss the importance of irrigation
- list sources of water suitable for irrigation
- determine the suitability of water for irrigation

Key concepts

- Soil profile
- Soil composition and properties
- Organic and inorganic fertilizers
- Importance of irrigation
- Sources of water for irrigation

Introduction

Soil is the loose material on the earth's surface composed of organic matter, mineral matter, water, air and living organisms. Soil and water form the most important natural resources in agriculture. Agriculture cannot take place without soil and water. The soil supplies plant nutrients and serves as a medium for plants to grow. Plants can only use water stored in the soil which is absorbed through the roots.

Arrangement of soil layers, nutrient status and depth of soil are very important aspects of the soil that a farmer should know. This knowledge helps in better management of the soil and crops. Study of soil arrangements is known as soil profiling.

Farmers should be able to maintain and improve fertility of their soils. Farmers apply fertilizers and organic manures to improve nutrient status of the soil. There are different types of fertilizers and organic manures that farmers should know and apply correctly.

Organic manures have a lot of advantages and farmers should be able to prepare compost manure.

Water is required by plants and animals. However, it is not always available, and farmers will have to provide water to plants artificially, through irrigation methods. Irrigation enables crop production in drier regions as well as during dry spells. Yields and quality of crops is greatly improved when irrigation is used. There are many sources of water which can be used for irrigation. These include natural and man-made sources. Examples of sources of water for irrigation include dams, rivers, streams, wells and aquifers.

The soil profile

Soil profile is a vertical section of the soil that shows all of its horizons or soil layers.

General soil profile

- The topsoil is the richest part of the soil in terms of minerals and humus.
- When soil cover is removed, top soil is washed by high winds and running water, and soil becomes poor for plant growth.

Horizon O (top of the soil)

This is a dark coloured layer of soil composed of organic matter and litter (decaying leaves and twigs). The top most part of the horizon is a layer of humus which is organic matter in an advanced state of decomposition. Soil living organisms such as earthworms are found in this layer. The layer contains a dense mass of roots mostly from shallow rooted plants.

Horizon A (topsoil)

This a layer of soil below horizon O. This layer or horizon is characterized by presence of organic matter and many

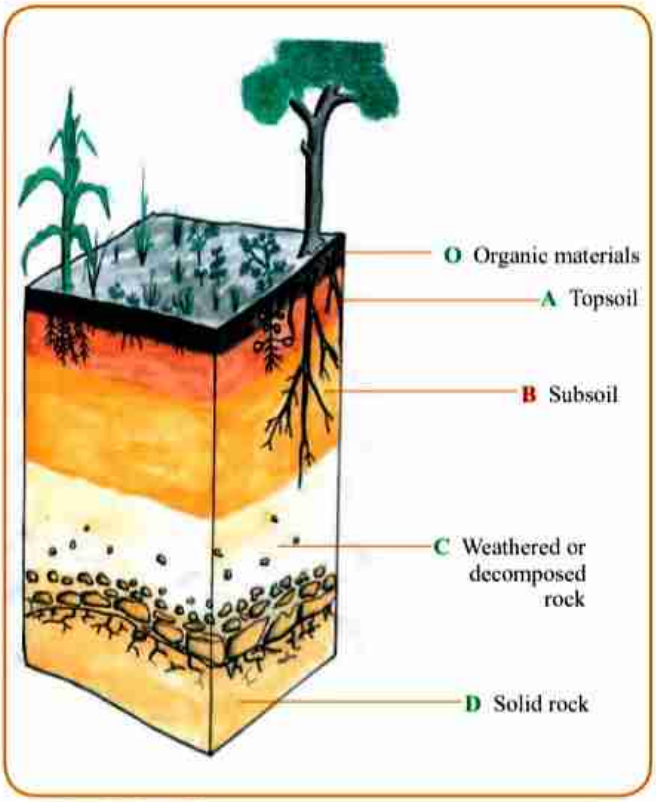


Fig. 3.1 Soil profile

soil organisms. There is high microbial activity in this horizon. The soils are generally dark in colour, likely due to high organic content. Most plant roots reach this zone.

Horizon B (subsoil)

The subsoil or horizon B is characterized by lighter coloured soils containing less organic matter. However, leached (washed down) nutrients from horizon A are deposited in the subsoil. There are very low microbial activities. The horizon contains few roots from only long or deep rooted plants that may have their roots reaching the horizon.

Horizon C (partially weathered rock)

This horizon is characterized by presence of partially weathered rock material breaking up from the parent rock. The layer does not support life and in this layer, there is no microbial activity. Very few plant roots may reach this layer, only the root tips from deep rooted plant species may rich this layer.

Horizon D (parent rock)

This is the parent rock. It is an unweathered and solid rock mass. It is also called the bedrock. It has no significance to plant growth. However, the properties of the type of parent rock when weathered will determine the resulting properties of soil formed by weathering.

Activity 3.1

Field observation of the soil profile (horizons)

Materials needed: metre ruler, tape measure, sketch books and pencils, 10 thick wire pegs that are 30cm long

1. Visit some possible areas with exposed soil layers (horizons), such as:
   - River banks or stream banks.
   - Roadside escarpments, especially on roads that are on hillsides.
   - Dug out pits or deep excavations.

Guidelines to field activities

- Identify local potential areas where better views of soil sections (horizons) can be viewed safely.

2. Make observations on the exposed soil profile.
3. Identify and name the horizons that are visible.
4. Place labelled pegs on identified and named horizons.
5. Mark the borders of each horizon with wire pegs.
6. Take measurements of the thickness of each distinct horizon.
7. Make a sketch of the arrangement of horizons that you see.
8. Record characteristic of each layer on your sketch diagram.

Importance of soil profile

Soil profile, as already discussed, is the vertical section of the soil, that is the arrangement of soil layers from the surface down till you reach a solid rock mass. Depths of soils or distance between surface and solid rock mass differ with places. Thickness of distinct horizons vary with places. This does not spare the organic, chemical and physical properties that also vary with places. These differences have a lot of effect on agricultural production. Knowledge about each soil profile will help in the following ways:

- Study of the soil profile will help to determine soil colour, structure and texture for agricultural purposes.
- From viewing the soil profile, root status (density, easy of movement) in each horizon can be assessed.
- The nutrient and organic matter content or status can be assessed through soil profiling.
- Determine moisture content and drainage of soil.
- Evidence of any toxic material can be assessed from the soil profile.
- Studying the soil profile will help to assess and determine soil depth.

Facts, observations and evidence gathered from the field study of the soil profile, will help the farmer to:

- Make decisions on the suitable type of crops to grow.
- Make best choices of land preparation methods that are most suitable to that soil for cropping.
- Determine plant nutrient supplements needed in the soil, in terms of the quantity and the type of fertilizer required to supply the needed nutrient.

Soil types, composition and properties

Common soil types are sand, loam and clay. Soils differ in their physical and chemical properties due to their compositions. Proportional compositions of particles determine the physical properties of soil. Soils can either be fine or coarse depending on sand and clay proportions making up the soil. Soil texture and soil structure are important properties of soil in agriculture. Soil texture is the degree of fineness or coarseness of a soil. Coarse textured soils are well drained and well aerated. Fine textured soils usually have good water holding capacity, but drainage and aeration are poor in these soils. Soil structure refers to arrangement of particles in a soil. The structure of the soil influences water movement as well as root development. Knowledge of soil properties and characteristics of different types of soils help farmers to select the most suitable crops favoured by the type of soil. This knowledge also helps in soil management for better yields.

Table 3.1 Soil types, composition and properties

Soil type	Composition and properties
Sandy soil 	• Sandy soil contains small rock and mineral matter. • Has large solid grains (particles range 0,02-30mm) • Well aerated. • Well drained soil that has easy of water movement through it. • Highly leached nutrients are easily washed from the soil. • It has a loose structure. • The soil is ease to work with. • Has poor water and nutrient holding capacity. • It is composed of more than 85% sand sized particles.
Loam soil 	• The soil is well drained. • It is well aerated, it has free air circulation. • Loam soil becomes sticky when wet. • Moderately leached. • Loam soil has good root penetration. • It has good water and nutrient holding capacity (keeps moisture for a longer period). • Particles making up loam soil are a mixture of sand and clay particles. • It is made up of 30% clay, 20% silt and 50% sand.
Clay 	• Clay soils are made up of very small soil particles (Less than 0,002mm particle size). • It is poorly drained; water movement is restricted by closely packed small particles. • Has good water holding capacity, retains moisture for very long periods. • Has good nutrient holding capacity. • Clay soils are hard when dry and not easy to work with when wet, because they become very sticky. • Movement of machinery may be a challenge because when wet, clay is slippery and sticky. • Contain 70% clay, 20% salt and 10% sand.

Activity 3.2

Collection of soil samples and identification of soil types

Materials needed: buckets, spade, garden trowels or any digging tool

1. Collect soil samples that you suspect to be sand, loam and clay.
2. Classify the soil samples into sand, loam and clay.
3. Justify the class of each sample (why you say its sand, loam or clay).

Experiment 1

Investigating water movement (drainage) through different types of soils

Apparatus: 4 clear jars or measuring cylinders, 3 funnels, 3 filter papers or cotton wool

Procedure

1. Collect soil samples of sand, loam and clay.
2. Measure 20g of each soil sample.
3. Partially block the funnel bottom of 3 funnels with a cotton ball to prevent soil draining down the funnel.
4. Place the 20g of each soil sample, clay, sand and loam into three different funnels.
5. Place the funnel filled with soil samples onto a measuring cylinder.
6. Gently add 50ml of water to each funnel with soil sample.
7. Allow the poured water to drain for 20 minutes, making sure all funnels drain for 20 minutes.
8. Compare the water collected in the measuring cylinders.
9. Comment on the amount of water collected from each sample.
10. Which soil samples show poor drainage and which samples show good drainage?
11. Record the results.

Experimental set up

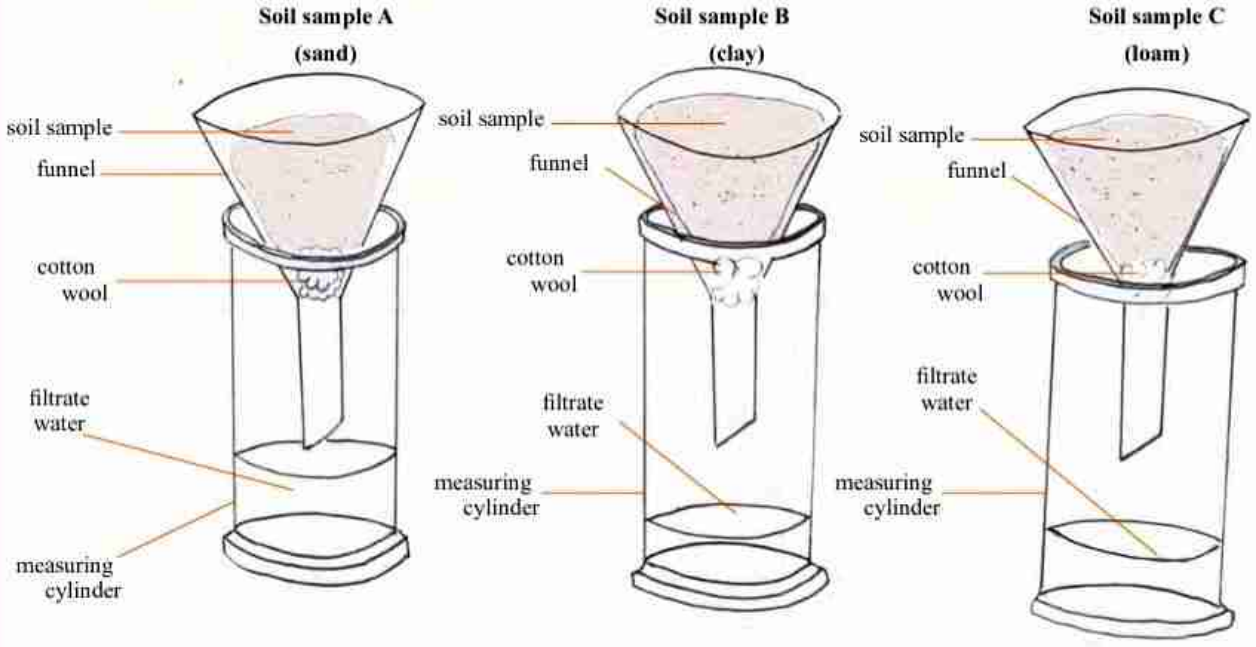


Fig. 3.2 Set up for investigating soil drainage

Experiment 2

Designing an experiment to determine soil texture

Background information

Soil texture is the degree of fineness or coarseness of soil particles making up a soil type. Texture of a soil is determined by proportional composition of various sizes of particles.

1. In convenient groups, design an experiment or method that can be used to determine soil particle sizes that make up a sampled soil type.
2. List the apparatus you are going to use.
3. Make a detailed layout of procedures you are going to take.
4. Diagrams may be included.
5. Carry out the experiment following your planned procedure and record the results of your findings in the farm diary.

Soil fertility

Soil fertility is the degree of richness of a soil or simply the nutrient status of a soil. Soils can be described as rich, moderate or poor in terms of nutrient and organic content levels.

The sources of soil nutrients vary. However, major nutrient sources are classified as either organic (containing carbon) or inorganic (man-made).

Farmers can greatly influence the nutrient status of their soil by adding nutrient supplements to the soil and organic matter.

Organic and inorganic fertilizers

Organic fertilizers

Organic fertilizers are the remains from decomposed plant and animal parts that release nutrients to the soil. Organic matter also helps to improve acidity and chemical reactions in the soil.

Table 3.2 Advantages and disadvantages of organic fertilizers

Advantages	Disadvantages
• Organic fertilizers are readily available. • They are relatively cheap. • Organic nutrients can be applied as basal or top dressing. • Manure improves soil structure. • Organic manures are a good source of nutrients required by plants.	• Organic fertilizers are bulky, large quantities are required to be effective. • A lot of labour is required to apply organic fertilizers. • Take long to prepare or to be ready for use. • They can spread diseases and weeds if not well decomposed. • Organic fertilizers supply unknown quantities of nutrients.

Types of organic manure

- Compost manure (decomposed plant material)
- Green manure (live field crops ploughed into soil)
- Farmyard manure (poultry manure, cow dung, cut grasses)
- Liquid organic manure

Compost manure: is a mixture of organic remains (residues) and soil that has been stacked in layers, moistened and allowed to decompose over some period of time.

Green manure: is any crop grown to a flowering stage then ploughed under to decompose. The most widely used green manure plants are legume crops which include sun hemp, cowpeas (nyemba)) and field beans.

Fig. 3.3 Green manure

Farmyard manure: farm yard manure includes cut grasses, animal wastes from poultry, cattle and goats, pig, sheep or horse.

Liquid organic manure: this is organic form of fertilizer that is prepared into a concentrated liquid form and is diluted to required concentration level. The simplest liquid organic manure is prepared by soaking Russian comfrey leaves in water at a particular ratio. The extract is then used as liquid manure.

Activity 3.3

Compost making

The size and dimensions of the compost heap depends on available organic materials. For this activity groups are assigned to a particular activity such as collecting organic material, watering, soil collection and making the compost layers.

Materials needed: 4 x 1.5 metre-long wooden pegs, shovel, wheel burrow, watering buckets or hose pipe, organic materials.

1. Peg out room for two or more heaps side by side, size of each compost will depend on available materials.
2. Put 250mm thick layer of weeds, leaves, vegetable wastes or stalks in the marked out area.
3. Add 50mm soil mixture of old compost or animal manure over the layer of organic materials.
4. Repeat steps 2 and 3 until there is a heap 2 metres high of alternating plant material and soil layers.
5. Water the layers as you build them up.
6. Water the compost heap once every week.
7. Turn the heap each month to invert the soil.
8. Test for heat or temperature by dipping a long stick or metal at the centre of the compost heap and feel how warm it is. It should not be hot as you take it out.

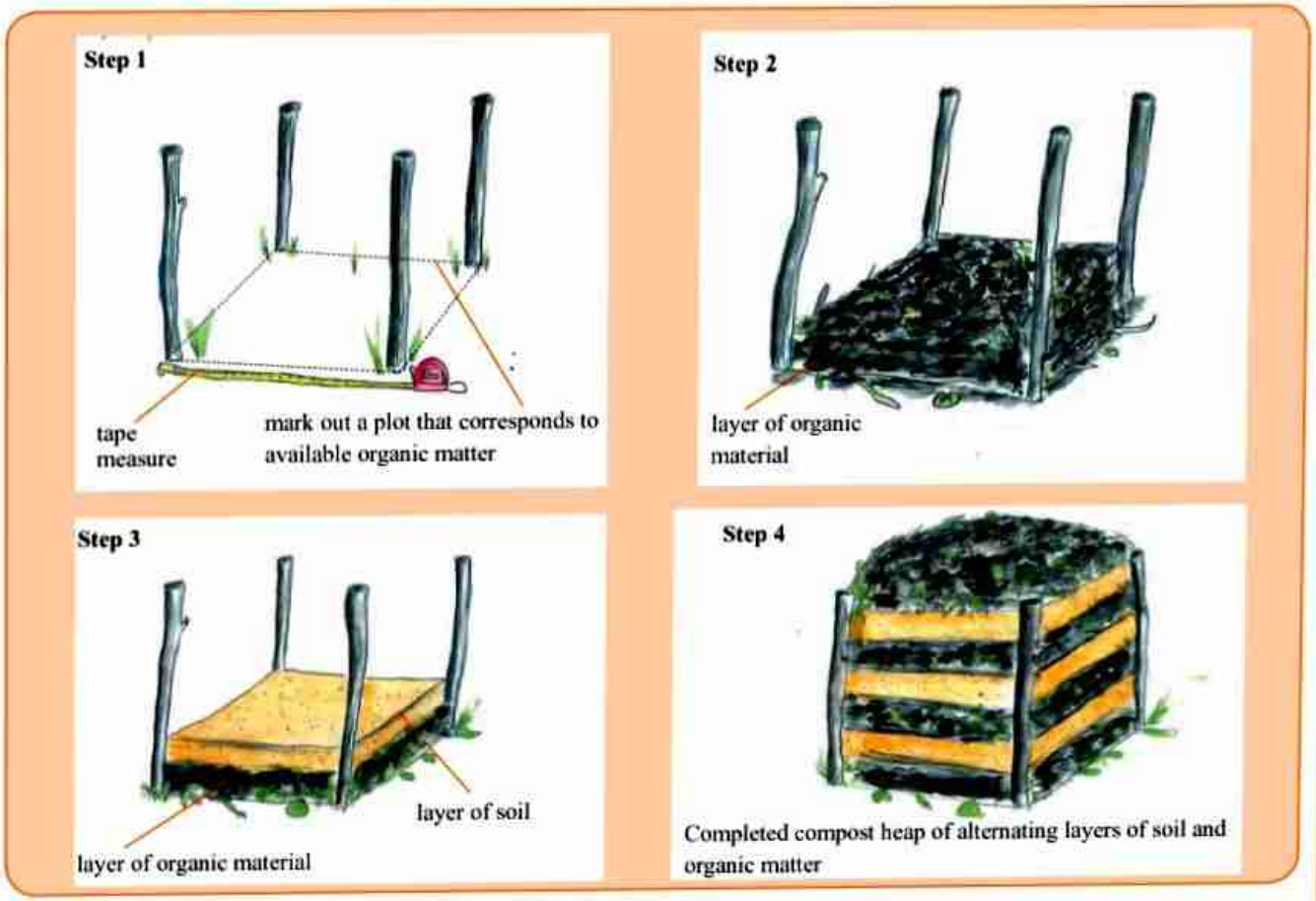


Fig.3.4 Summarized compost heap preparation steps

Inorganic fertilizers

Inorganic fertilizers are man-made or synthetic nutrient formulations that do not contain the natural element carbon. These fertilizers are obtained from fertilizer manufacturers and are grouped into straight and compound fertilizers. Inorganic fertilizers are obtained in granular forms packed in branded bags that show nutrients supplied and percentage composition of the nutrients.

Compound fertilizers

These are inorganic fertilizers containing more than one major nutrient applied as basal dressing before planting crops or applied at planting. Compound fertilizers are sold in granular form. Table 3.3 shows advantages and disadvantages of compound fertlizers.

Table 3.3 Advantages and disadvantages of compound fertilizers

Advantages	Disadvantages
• They supply at least 2 or more major nutrients and some may apply micro nutrients. • Required nutrients are applied at once. • It has low labour costs as nutrients are applied at once. • It is granular and therefore easy to apply. • Supply known quantities of nutrients. • Compound fertilizers are applied as basal fertilizers that promote healthy plant establishment.	• Supply some nutrients not lacking in the soil hence leading to wastage or nutrient toxicity when there is oversupply of nutrients. • Costly as they are compounded by the manufacturer. A farmer cannot make a specific formulation but has to buy from manufacturers.

Straight fertilizers

Straight fertilizers are inorganic formulations that supply only one major nutrient such as nitrogen, phosphorus or potash. They are used as top-dressing fertilizers or for addressing nutrient shortages. Table 3.4 shows advantages and disadvantages of straight frtilisers.

Table 3.4 Advantages and disadvantages of straight fertilizers

Advantages	Disadvantages
• Reduces costs by applying the specifically required nutrient. • Exact amount of nutrients recommended are applied. • Straight fertilizers are mobile (move within the soil).	• More labour is required if more than one nutrient is needed at a time. • More storage space is needed for storage of different fertilizers.

Activity 3.4

Familiarizing with various inorganic fertilizers

1. Identify different types of inorganic fertilizers from the agriculture storeroom, a fertilizer warehouse, internet websites, local farmers or shops.
2. Record the nutrient information on fertilizer bags, such as nutrients supplied and percentage composition of nutrients supplied by the fertilizer.
3. Record the characteristics of each type of fertilizer. What do you think makes these fertilizers different?

Irrigation

Irrigation is the controlled artificial application of water to plants at regular intervals to supplement rainfall or to grow crops in dry seasons. Various methods are used to water plants, the simplest method being the manual irrigation using handy containers or watering cans. There are mechanized forms of irrigation that use specialized infrastructure and equipment, examples are sprinkler irrigation, centre pivot and drip irrigation. Flood irrigation methods where water flows on land's surface to supply the crops are also other forms of irrigation methods.

Flood irrigation methods include ridge and furrow irrigation method, corrugations and border strip method. The various methods used in agriculture are shown in Figure 3.5.


sprinkler irrigation


centre pivot


ridge and furrow


drip irrigation

Fig. 3.5 Various irrigation methods

Importance of irrigation

Water is a critical input to plant growth and development. Plants cannot grow without water. Plants need water for photosynthesis, a process where plants absorb water and carbon dioxide to make their own sugars using sunlight. Water pressure in plants help them to be upright and to be firm (turgid).

In Zimbabwe, most farmers practice irrigation. This is mainly because of unreliable rainfall patterns in some areas, especially in dry regions of the country such as in natural regions III, IV, and V. Rainfall in Zimbabwe is seasonal. This means that there will be no rain in some seasons. Farmers who want to grow crops throughout the year need irrigation water. The following are some of the general importance of irrigation:

- Irrigation enables farmers to grow crops during the dry season when there are no rains.
- Irrigation helps to supplement rain water during times of inadequate rainfall.
- It helps to extend the growing period of crops by enabling farmers to plant early before onset of natural rains or by irrigating the crops after the rains have stopped.
- Crop quality is greatly improved by irrigating crops.
- Irrigation can be used to control or minimize effects of frost on crops, especially when crops are irrigated during periods when frosts are most likely to occur.
- Farmer's income is improved as production throughout the year is made possible by irrigation.
- Irrigation infrastructure such as dams, pipe networks that supply irrigation water and water pumping equipment increases the value of the farm.
- Irrigation can be used to cool plants during periods of extremely high temperatures.

Activity 3.5

Discussion on the importance of irrigation

1. Identify local irrigation practices in your community and list them as the basis of your discussion.
2. Discuss how local irrigation methods are practiced.
3. What are the importance of irrigation methods?
4. What are the significant contributions of the irrigation methods to agricultural production in your area?

Activity 3.6

Touring an irrigation scheme

1. Identify a local farm where sound irrigation is practiced.
2. Visit the farm and make as many observations on irrigation as possible.
3. Probe for information by asking the farm personnel and facilitator questions.
4. Record your findings.

Sources of irrigation water

There are various places where water for irrigation can be drawn. Sources of water for irrigation range from naturally existing sources to artificial sources that are constructed by man. Quality of water, volume of available water and levels of pollutants in the water determine its suitability for crops. Water with high levels of salts and pollutants is not suitable for most crops. Small volumes of water may not be adequate for some large scales of irrigation. Various sources of water exist as natural or artificial, they include sources such as:

Natural water sources

- Rivers
- Streams
- Lakes
- Aquifers

Artificial (man-made) water sources

- Dams
- Ponds
- Wells
- Weirs
- Canals
- Borehole water

Dams and lakes

Dams and weirs are man-made constructions built across rivers to build up volumes of water from flowing rivers. Dams are constructed to collect runoff so as to build large reserves of water for use in irrigation.

Dams and weirs are of different sizes. We have small earth dams constructed on farms and large dams which supply water for irrigation. Lakes are larger versions of dams, and lakes can stretch for over hundreds of kilometers.

Example of large dams in Zimbabwe include Gwenhoro dam, Kunzvi dam and Osborne dam.

Examples of lakes include lake Muturikwi, Lake Chivero and Lake Kariba. Below is a photograph of Lake Mutirikwi.

Fig.3.6 Lake Mutirikwi

Weir

Fig. 3.7 A weir

- A weir is a cement or masonry wall built across a river to hold water and to build up a water reserve without stopping the flow of water. As a result, a small pond is created. Water overflows over the masonry or cement wall. It is built to allow better pumping volume of water to the field. Some rivers are shallow to such an extent that the suction pipe of the pump cannot draw water safely without sucking mud which damages the pump. A weir helps to solve this problem.

Borehole

- A borehole is a sunk water hole, which is sunk to access underground water for various uses. Usually water is drawn underground using manual or electric pumps into tanks before it is used for irrigation.

Rivers

- A river is a natural watercourse on the earth's surface whose size and capacity is governed by its catchment area. Most farmers use local rivers for irrigation.

Wells

These are deep excavators dug to water table. Water will then be extracted manually or by pumps for irrigation.

Fig. 3.9 A well

Water quality

Water quality refers to the chemical, physical, biological, and radiological characteristics of water. Water is very important because not all water is suitable for irrigating agricultural crops. Some water sources are polluted to an extent that they cannot be used to water crops.

It is therefore important to manage wastes properly, minimize the use of persistent chemicals and use improved farming methods that do not contaminate or pollute water sources.

Fig. 3.8 River supplying irrigation water

Factors affecting water quality

1. **Pollution:** pollutants or impurities can be released into the environment as gases, liquids, dissolved substances or particles and can enter aquatic ecosystems by atmospheric deposition, soil erosion, seepage, runoff or direct discharge.
2. **Gold panning activities:** Gold panning can result in water pollution from chemicals such as mercury used in the processing of gold by panners.
3. **Recreational activities:** Motorized water racing can pollute water through oil and fuel leakages.
4. **Mining**: The use of cyanide in gold treatment can pollute water.
5. **Agricultural chemicals**: Pesticides and fertilizers washed into water bodies pollute water bodies.

Summary

- Soil is the loose material covering the earth's surface, comprising organic materials, mineral matter, air and water.
- The soil profile is the view of the vertical section of the soil from soil surface down to the impermeable rock mass.
- Soil is made up of layers of different properties and characteristics with different abilities to support plant life.
- The study of the soil profile of an area helps to establish the status of the soil which in turn helps the farmer to determine required nutrients and amounts when soils are tested.
- Facts gathered from soil profiling help the farmers to select crops best suited to their soils.
- There are three main basic types of soil, sand, clay and loam.
- Soil fertility refers to the nutrient status of the soil.
- Plant nutrients are supplied by organic and inorganic fertilizers.
- Organic fertilizers are made up of decomposed living matter that contains the natural life element called carbon.
- Inorganic fertilizers are synthetic or man-made plant nutrient formulations that supply plant nutrients.
- Compound fertilizers are artificial fertilizers that supply more than two major nutrients.
- Straight fertilizers are artificial fertilizers that supply a single major nutrient.
- Irrigation is the artificial application of water to crops to supplement rainfall or to grow crops in the absence of rainfall.
- Irrigation enables crop production to be carried all year round, during dry seasons and drought periods.
- Water for irrigation can be obtained from various sources such as rivers, streams, lakes, dams, wells and boreholes.

Glossary

Organic matter:	is material consisting of plant and animal remains (residues) at various stages of decomposition
Inorganic matter:	is a chemical compound that does not contain carbon
Aquifer:	this is an underground water source
Synthetic:	material that is not of natural origin
Turgid:	firmness in plants as a result of water pressure in plant cells
Top dressing:	application of a straight fertilizer to address particular nutrient shortages
Basal fertilizer application:	application of compound fertilizer done before planting or at planting
Drainage:	movement of water within soils
Leaching:	this is the downward washing away of nutrients by excess water to levels beyond the reach of most plant roots
Parent rock:	solid rock mass that weathers to form soil above the rock
Persistent chemicals:	these are chemicals that remain active for a long period of time well after the goal has been achieved
Catchment area:	areas from which rivers source water collected from rainfall

End of chapter questions

1. Which horizon of the soil profile supports plant growth?
   A. top soil B. subsoil C. parent rock D. Humus
2. The parent rock is a…
   A. hard soil B. solid rock C. weathered rock D. soil top
3. Select the list with properties of sand soil.
   A. single grained, well drained, poor water holding capacity
   B. closely packed particles, poorly drained, good nutrient status
   C. single grained, good nutrient status, good drainage
   D. single grained, good moisture retention, heavily leached
4. A straight fertilizer supplies…
   A. two major nutrients B. single major nutrients
   C. three minor nutrients D. three major nutrients
5. Select a list with natural sources of water.
   A. river, dam, borehole B. river, stream, aquifer
   C. river, weir, borehole D. stream, pond, dam
6. Define a) soil profile
   b) horizon [2]
7. Draw and clearly label a soil profile. [6]
8. Describe the characteristics of top soil. [3]
9. Differentiate clay, sand and loam soils. [9]
10. Give the differences between compound and straight fertilizers. [4]
11. Explain what is meant by green manure. [2]
12. List three types of organic manure. [3]
13. Describe the characteristics of:
    a) sand soil
    b) clay soil
    c) loam soil
14. List the advantages of using irrigation schemes in agriculture. [4]
15. Name an example of a straight fertilizer. [1]

CHAPTER 4

Plants classification and reproduction

Chapter objectives

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

- differentiate monocotyledonous from dicotyledonous plants
- state botanical classes of crops
- draw structures of maize and bean flowers
- label the parts of a flower
- state the functions of flower parts
- differentiate between sexual and asexual reproduction
- state advantages and disadvantages of sexual and asexual reproduction
- describe pollination of maize and bean flowers
- describe fertilization processes in plants
- explain different methods of asexual reproduction
- state requirements for seed germination
- differentiate between seed germination and emergence
- identify external and internal parts of maize and been seed

Key concepts

- Structure of a flower
- Reproduction
- Germination

Introduction

General plants and agricultural crops have biological similarities and differences that they display. Plants are classified according to biological similarities, into botanical classes. In agriculture, crops can further be grouped according to the parts eaten or used. Classifying crops helps in management and identification of crops. Crops of the same natural family share common pests and diseases. Crops with similarities usually require the same agronomic practices. Thus, plants may fall into a number of classes depending on the feature being looked at or the criteria of classification.

Flowering plants are plants that produce flowers as organs of sexual reproduction. The plant flowers can be made up of male and female parts on the same flower as in beans, or alternatively, some plants have male and female parts existing separately such as in maize plants. It is important to understand the processes that involve reproductive parts to influence the processes or avoid disturbing the processes for maximum productivity.

Plants reproduce sexually or asexually. Sexual reproduction involves the generation of new plants with the involvement of male and female parts of the flower. Plants that reproduce asexually do not have flowering structures but new plants are generated from parts of existing plants such as stems, tubers and bulbs. Farmers can also practice artificial asexual reproduction methods to produce new plants. These include use of cuttings, tubers, grafting, budding and layering.

The seed is the product of flower fertilization used for generation of new plants for most agricultural crops. For seeds to germinate or develop into new plants they require specific conditions, some of which should be supplied by the farmer for successful crop production. The understanding of plant classes, reproductive processes and germination processes and requirements will greatly improve crop production and management practices carried out by a farmer.

Classification of plants

Monocotyledonous and dicotyledonous plants

Flowering plants can be classified into two broad groups which are monocotyledon and dicotyledon. The classification of plants into monocots and dicots is based on the number of cotyledons present in the seed. The seed type can either have a single cotyledon or two cotyledons present in the seed. There are other characteristics of the plant such as leaf structure that can be used to identify these two classes.

Monocotyledonous plants

This is a class of plants that produce seed containing a single cotyledon. They are mostly grasses, cereal crops and palms.

Characteristics of monocotyledons

- the seed contains only one cotyledon
- the plants have narrow shaped leaves
- monocotyledons have parallel veined leaves

Fig. 4.1 Monocotyledonous leaf (maize leaf)

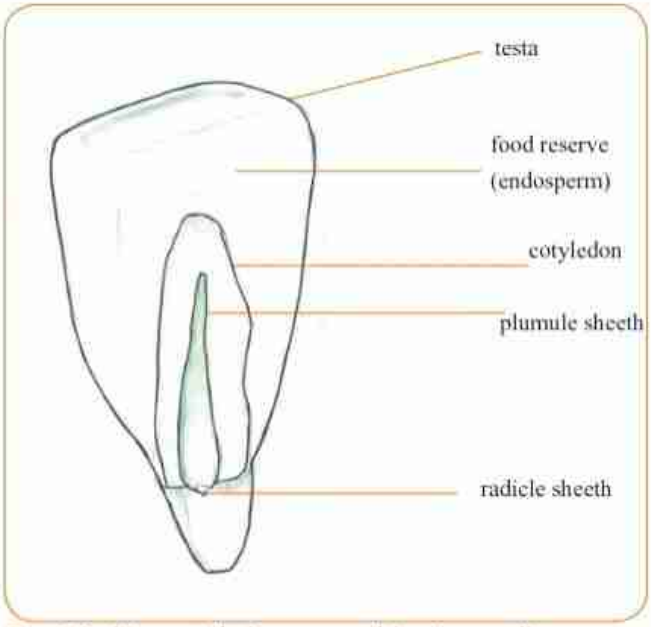


Fig. 4.2 Monocotyledonous seed (maize seed)

Dicotyledonous plants

These are plants that produce seeds with two cotyledons. A wide range of plants fall in this class even though they might belong to other classes by a different classification criterion. Evergreen trees, shrubs, herbaceous plants and deciduous trees fall in this class.

Characteristics of dicotyledons

- dicotyledons have seed that has two cotyledons
- the plants have broad shaped leaves
- the leaves are net veined

Fig. 4.3 Dicotyledonous leaf

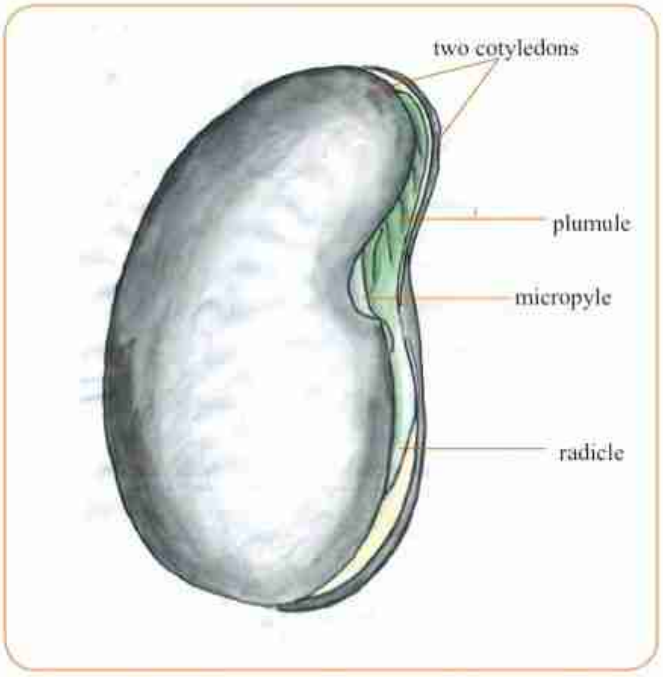


Fig. 4.4 Dicotyledonous seed structure (bean seed)

Table 4.1 below shows a summary of the characteristics of dicotyledon and monocotyledon plants.

Table 4.1 Summary of the characteristics of dicotyledon and monocotyledon plants

Class	Description feature
• Dicotyledon plants	• Have two cotyledons in seed • Leaves have branched veins • Have a main roof with fibrous roots • Perennial plants have woody stem • Examples include groundnuts, tomatoes, soya beans, sunflowers
• Monocotyledon plants	• Have one cotyledon in seed • Leaves have parallel veins • Have a fibrous root system • Perennial plants have soft stem • Examples include maize, wheat, rice, onion, and banana

Botanical classification of plants

This refers to a scientific classification of plants into families according to biological characteristics. Plants of the same family share common features and are somewhat related. Botanical classes of agricultural crops include leguminous plants, brassicas, solanaceous plants, graminae (cereals) and curcurbits.

Leguminous plants

Leguminous plants or legumes are a class of plants that are capable of fixing atmospheric nitrogen into the soil. These are plants such as peas, beans, groundnuts, round nuts and soya bean. Legumes have root swellings called nodules where specific strains of rhizobia bacteria are hosted. The bacteria in the swellings respire fixing nitrogen into the soil. The rhizobia bacteria can only survive symbiotically on legume plants only.

Fig. 4.5 Typical legume root nodules

Fig. 4.6 Leguminous crops

Brassicas

This is a family of plants made up of leaf vegetables such as cabbage, rape and cauliflower, amongst others. Mostly the leaves are the consumed part of the plant, except in plants sucha as cauliflower where the leaves and flowers are both consumed. Some common examples are shown in the illustrations below.

Fig. 4.7 Brassicas

Solanaceous

The solanaceous family is a class of plants such as tomatoes and potatoes.

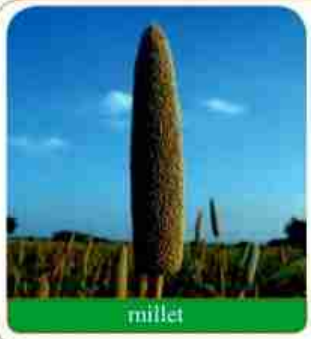

potato


tomato

Fig. 4.8 Some plants in the solanaceous family

Graminae (cereals)

This is a family of grass crops mostly grown for grain. Examples of crops in this class are maize, wheat, rapoko, millet and barley, amongst others.


millet


maize

Fig. 4.9 Some plants in the graminae family

Curcurbits

These are herbaceous plants, some of which produce fruit. Examples of plants in this family include cucumber, pumpkin, squash and watermelons.


cucumber


watermelon


pumpkin plant

Fig. 4.10 Some curcurbit plants

The table below shows botanical names of some common garden field crops.

Table 4.2 Botanical names of common garden field crops

Botanical names and families	Example
Cucurbits	cucumbers, pumpkins
Solanaceous	pepper, tomatoes, potato
Zeamays	maize
Legume	groundnuts, soya beans
Brassica	rape, cabbage, choumollier
Solanum tuberosum	Potatoes
Dorcus carrota	Carrots
Graminae	Cereals

Activity 4.1

Plant classification

1. Collect five field crops and five garden crops.
2. Classify them into cotyledonous and monocotyledonous plants.
3. Find out the botanical names of each crop collected.

Activity 4.2

Classification of seeds into monocotyledons and dicotyledons

Materials: scalpel blades, maize seed, bean seed, petri dishes, seed from a variety of agricultural crops

1. Collect or list agricultural crops common to you.
2. Group the crops into groups with similarities and record the plants and groups formed.
3. Soak maize and bean seed until they soften.
4. Carefully split the seeds to observe the cotyledons.
5. Collect various seeds, soak them in water for some time.
6. Split the various seeds collected and match their inside appearance to that of maize and bean seed.
7. Classify the various seeds into monocotyledons and dicotyledons basing on the observable comparisons with split maize and bean seeds.

Structure of a flower

The flower is the sexual organ of the plant for reproduction. Flowering structures may differ with types or classes of plants. There are plants with flowers made up of male and female parts on the same flower such as is the case with bean flowers. Maize and other similar plants show a different flowering structure to that of bean flower. Understanding these flowering structures and how they function helps in improvement of plant management and environmental care for sustainable production.

The structure of a bean flower

A bean flower is a typical example of an insect pollinated flower, whose male and female parts are enclosed in petals. The male parts are the anther and the filaments. Female parts are made up of stigma, style, ovary, ovules and petals.

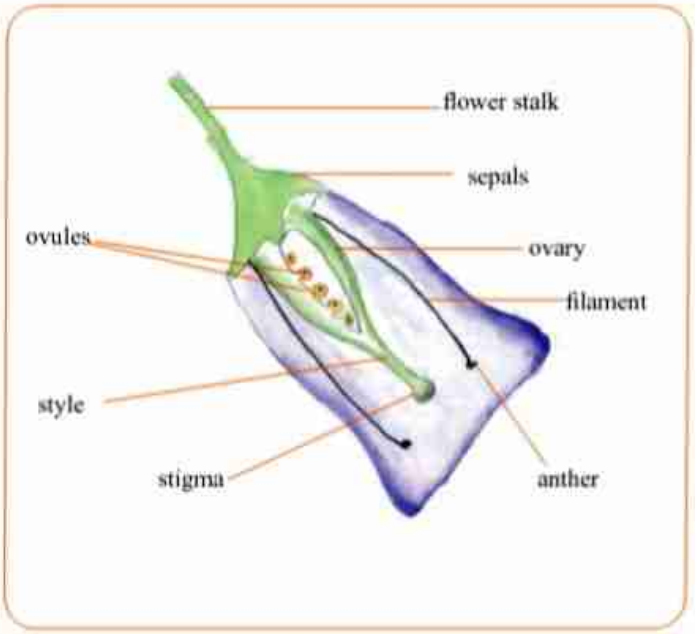


Fig. 4.11 A bean flower

Table 4.3 Functions of bean flower parts

Part	Functions
Receptacle	• large end of flower stalk which bears other parts of the flower.
Sepals	• these protect the entire parts while in bud. They have dull colour.
Petals	• are brightly coloured and attract insects.
Ovary	• is a female part which contains female sex cells called ovules.
Ovules	• female sex cells which when fertilized, develop into a seed.
Style	• holds the stigma into position. Also leads pollen tube into the ovary.
Stigma	• is the female organ which receives pollen grains.
Filament	• the filament holds the anther into position.
Anther	• male part of a flower containing pollen grains.
Pollen grains	• are male sex cells which fuse with female sex cells to form a zygote.

The maize flower

Maize flower is made up of male and female parts that exist on separate locations on the plant. Flowering structure of maize is made up of the tassel, silks and cob.

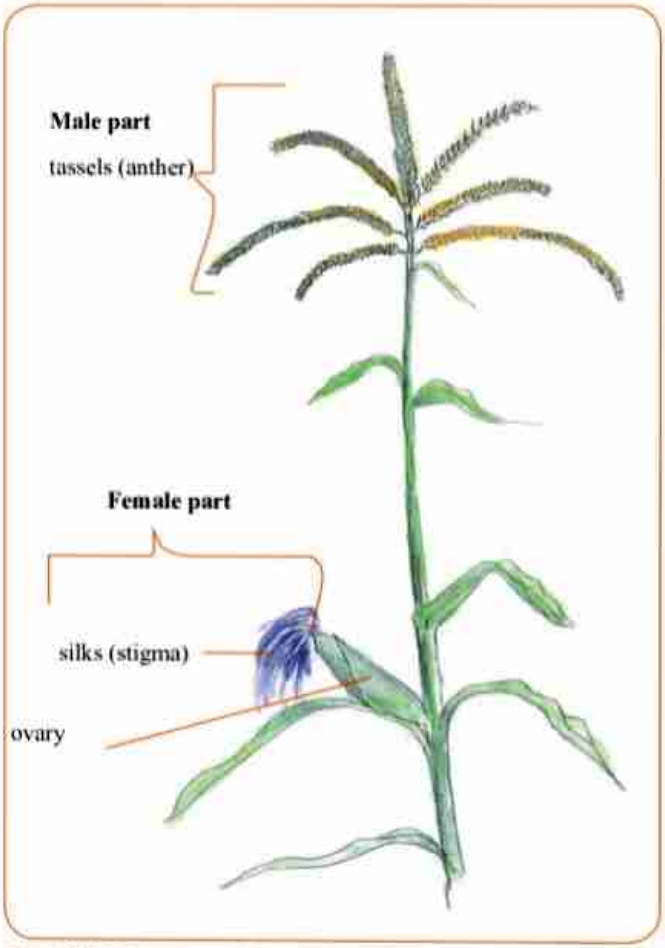


Fig. 4.12 The maize flowering structure

Table 4.4 Maize flowering parts and their functions

	Flower part	Function of the part
Male parts	Tassel	• Produces pollen grains
Female parts		
	Stigma (silks)	• Receives pollen grains
	Ovary	• This is the site for fertilization • Contains ovules • Ovary develops into fruit in some plants
	Ovules	• Fertilized ovules develop into seed

Activity 4.3

Identifying maize and bean flower parts from live specimens

1. Collect maize and bean flowers from the school garden.
2. Identify parts of the flowers.
3. Draw and label the identified parts of the flowers.
4. Describe functions of the identified flower parts.
5. Describe how the parts are adapted to their functions.

Plant reproduction

Plant reproduction refers to the generation of new plants. Generation of new plants or plant propagation occurs through sexual means and asexual or vegetative means. Sexual reproduction involves male and female parts of the flower. Asexual or vegetative reproduction involves generation of new plants from parts of existing plants such as stem cuttings and rhizomes. Farmers can also practice artificial vegetative propagation by manipulating and modifying natural vegetative reproduction processes to produce new plants.

Sexual plant reproduction

The flower is the main reproductive organ in plant sexual reproduction. The main stages in sexual reproduction are pollination, fertilization and germination. After fertilization has taken place, the fertilized ovules develop into seed which later when provided with necessary conditions will germinate and develop into a new plant.

The major advantage of sexual reproduction is that it allows pollen grains of different plant origins of the same species to pollinate and fertilize. This brings out new assortments of characteristics and varieties that are superior to parental plants.

Examples of plants propagated through sexual reproduction include maize, groundnuts, beans, sunflower, sorghum, wheat and peas.

Pollination

This is defined as the transfer of pollen grains from the anther to the stigma by either insects such as bees or gentle winds. Pollination is very important to agriculture. Farmers should know that a good yield will occur when most of the flowers produced by a plant have been pollinated. Only pollen grains of plants of the same species will further develop after landing on the stigma.

Farmers should not harm certain insects, such as bees, that are beneficial to agriculture. Bees pollinate plant flowers which helps to improve yields, especially in fruit production.

Plant flowers have special adaptations to wind or insect pollination. Insect pollinated flowers are usually scented, produce sweet nectars and are brightly coloured so as to attract insects that pollinate them. Wind pollinated flowers usually have stigmas that are haiy and feathery, hanging out of the petals and exposed to the wind.

Plant flowers can undergo self-pollination or cross pollination. Self-pollination is when pollen from the anthers of a flower is transferred to the stigma of the same flower. Cross pollination occurs between flowers on separate plants. The stigma receives pollen from anthers on flowers that are on a different plant of the same species. Special mechanisms ensure that there is cross pollination. The anthers mature first before the stigma is mature to receive pollen.

This ensures that pollen from the same flower will not pollinate that flower. There are other plants where the stigma matures first and becomes receptive to pollen before the anthers are mature to prevent self pollination.

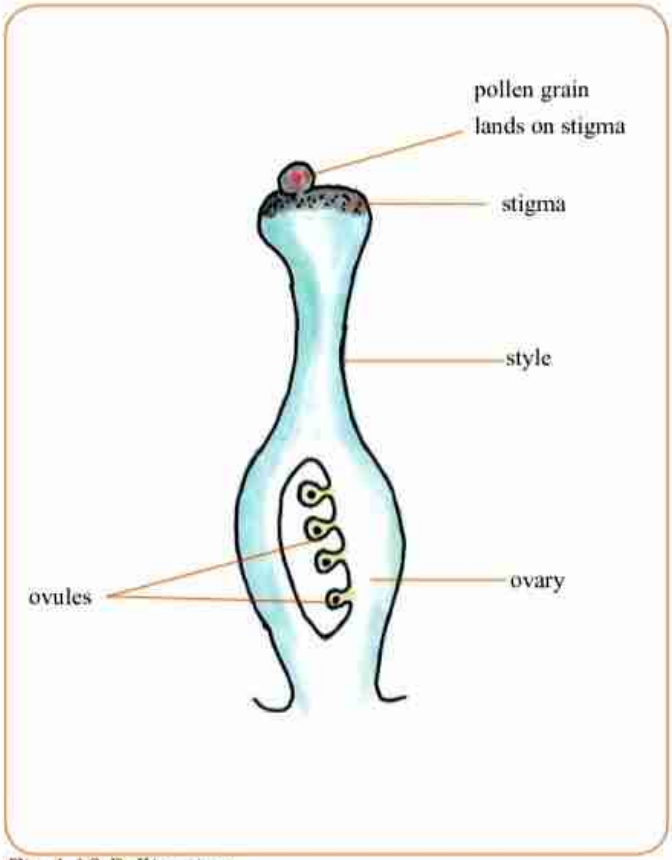


Fig 4.13 Pollination

Comparison of wind pollinated and insect pollinated flowers

Table 4.5 Wind pollinated and insect pollinated flowers

Wind pollinated	Insect pollinated
• No nectar	• Produce nectar to attract insects
• Has no scent	• Are scented to attract insects
• Small petals which are dull coloured	• Have large brightly coloured petals to attract insects
• Anther hang loosely out of the flower	Short anther inside the flower
• Large quantities of small light and dry pollen grains are produced	• Pollen grains are produced
• Feathery stigma which hangs outside the flower	• Sticky stigma which is found inside the flower

Activity 4.4

Examining some plant flowers for pollination

1. Collect the following plant flowers: maize (male and female), grass flower, bean flower.
2. Identify features which make each flower either a wind pollinated flower or insect pollinated flower.
3. Draw each flower and label the features which make the flower adapt to a type of pollination.
4. a) Visit a flower garden and observe insect-pollinated flowers.
   b) Using particular insect-pollinated flowers you observed, list their main features.

Plant fertilization

Fertilization is the fusion or joining together of male (pollen) nuclei and female (ovule) nuclei to form a zygote that develops into seed embryo. Fertilization can only occur after successful pollination has taken place. Figure 4.14 is an illustration of how fertilization takes place.

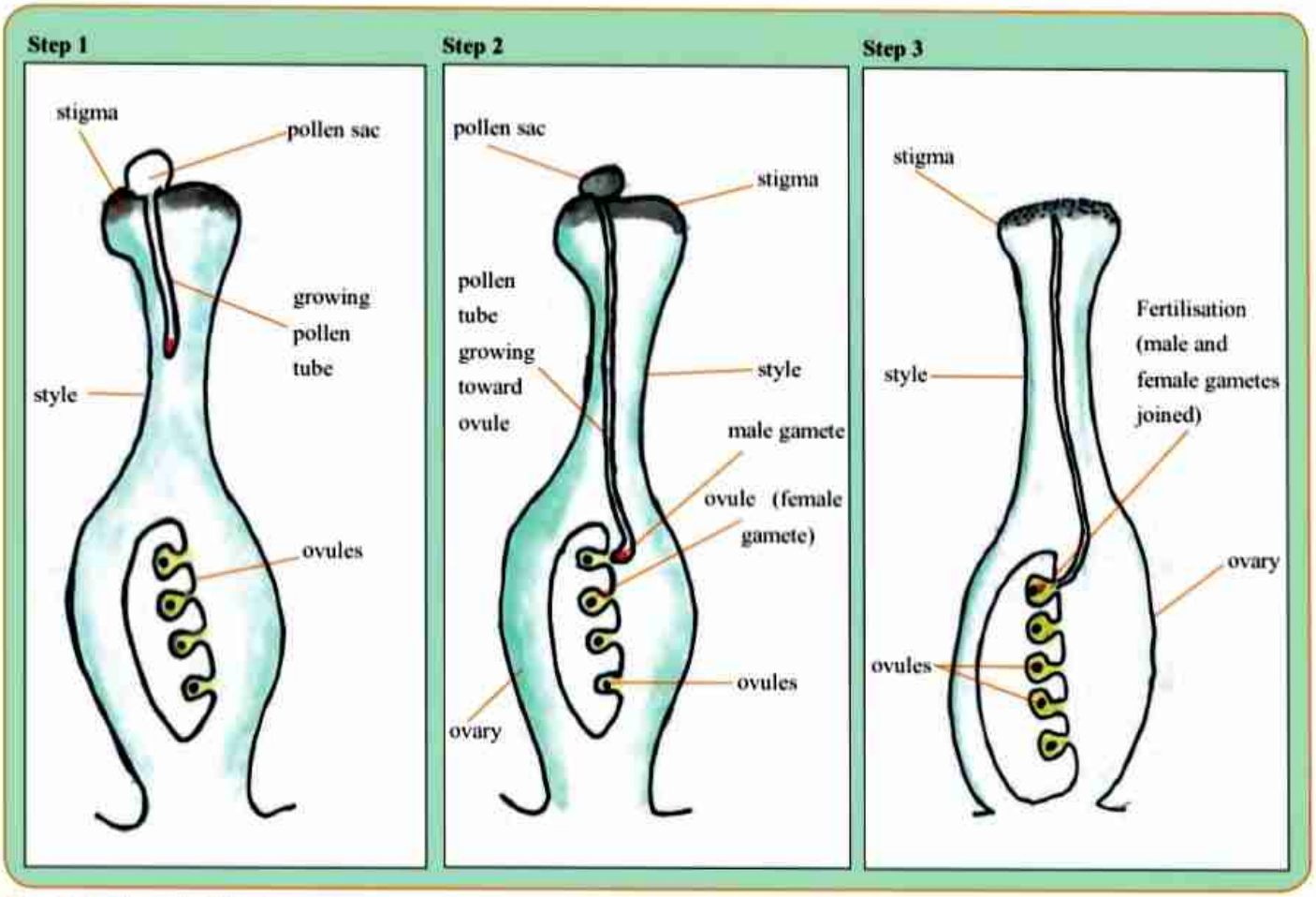


Fig. 4.14 Plant fertilization process

Results of successful fertilization

Following successful fertilization, the ovary will develop into a fruit. The stigma and style wither and so does the petal.

The fertilized ovules, in the ovary, will develop into viable seeds that are capable of germinating and developing into new plants. Each pollen grain develops its own pollen tube towards an unfertilised ovule.

Advantages of sexual reproduction

- Sexual reproduction produces new varieties of crops when cross fertilization occurs.
- Many plants can be produced at once in a short space of time.
- Method can be used to produce hybrid crops.
- Seeds are easy to store for use in favorable conditions.
- Mechanized planting using planters can be done with seed to cover large portions of land.

Disadvantages of sexual reproduction

- The method is expensive for farmers as hybrid seed will have to be purchased every production season.
- The method does not maintain some characteristics over generations, such as taste.
- Unfavourable conditions may result in death of some seedlings.
- Seed produced fruit trees take long to produce fruits.
- Seeds have smaller food reserves and developing plants may die.

Activity 4.5

Watching video simulations on fertilization process in plants

1. Computers, cellphones and tablets can be used for this activity.
2. Access the start menu and click on your browser.
3. Search engines such as google can be used to search for videos by typing in key search words such as "*animated videos of fertilization*".
4. Alternatively visit YouTube site by entering the address www.youtube.com and choose an appropriate video.
5. If you do not have access to internet, observe fertilisation processes taking place in your school garden. Observe activities around insect and wind pollinated flowers.

Experiment 1

Demonstration of a pollen tube after pollination

Apparatus/materials: microscope or magnifying glass, sugar solution, blank microscope slide, cover slip, pollen grains

1. Prepare 10 mls of concentrated sugar solution.
2. Place a drop of the sugar solution on the blank microscope slide.
3. Place a few pollen grains on the sugar drop and cover the drop with a cover slip.
4. Place the prepared slides on the microscope stage.
5. Using low power lens of 10 x (magnification), focus on the sugar drop.
6. Identify the pollen grains and leave the setup for about 20minutes or more.
7. Observe changes and any signs of pollen tube development.
8. Draw your observations.

Asexual (vegetative) reproduction

This method of plant propagation occurs naturally or with the influence of farmers. Pollination and fertilization processes are not necessary for generation of new plants. The flower is not involved in the process of producing new plants.

Natural asexual reproduction

Naturally, new plants are produced from some plant parts that develop their own rooting systems and become independent plants. This normally occurs during the rainy season. There are several vegetative plant parts that vary with type of plants that can naturally develop into new plants.

The following are examples of vegetative parts that develop new plants.

Bulbs

A bulb is a heavily condensed fleshy shoot with buds that can develop into new plants.

Fig. 4.15 Bulbs

Tubers

A tuber is a swollen plant part rich with food reserves, that has buds that develop into shoots and subsequently new plants.

Fig. 4.16 Sprouted potato

Rhizome

These are modified underground stems that can develop into new plants. In some plants they are swollen with food reserves.

Fig. 4.17 Ginger

Stolons

Stolons are underground stems similar to rhizomes but do not store food reserves. Stolons naturally develop into new plants.

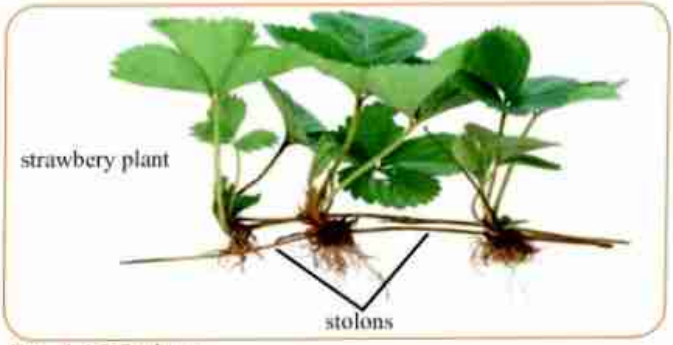


Fig. 4.18 Stolons

Corms

Corms are underground structures that can develop into new plants, such as in coco yams.

Fig. 4.19 Coco yam corm

Suckers

Suckers are side shoots that can develop roots and become independent plants.

Fig. 4.20 Banana suckers

Runners

Runners are surface stems that run parallel to the ground. The stems develop new roots on sections where they touch the ground. Areas that develop roots become separate or individual plants.

Fig. 4.21 Strawberry (runner plant)

Artificial asexual reproduction methods

Farmers make use of natural processes and influence or modify them to produce new plants for commercial production. Artificial methods of propagation include stem cuttings, grafting, budding and layering.

Stem cuttings

This method involves the use of stem cuttings of a convenient length with at least three buds. The cut stem parts must be selected from healthy plants with desired characteristics and are buried in soil under special care until they grow roots and develop shoots. Watering is necessary to speed up root growth. This method is very common with plants such as cassava, sugarcane and mulberry.

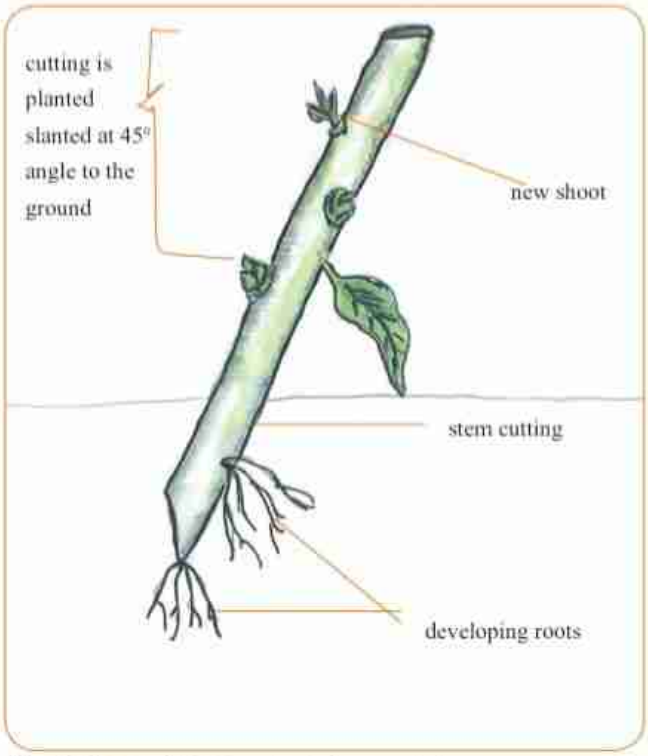


Fig. 4.22 Establishing plants from cuttings

Grafting

Desired plants are produced by joining parts or branches of plants with buds that shoot into plants to a root stock or part of plant that provides rooting structure. For successful joining and healing, the cambiums of the two different plant parts must be in contact.

The main parts used are the scion (shoot source) and the root stock which provides the rooting structure for joined scion. The joined area should be disinfected and tied with a cling wrap plastic to prevent infections up until the wound heals. The grafted plant should be kept under close monitoring in a nursery. Grafting is common in most fruit trees such as citrus, mango, apple and peach.

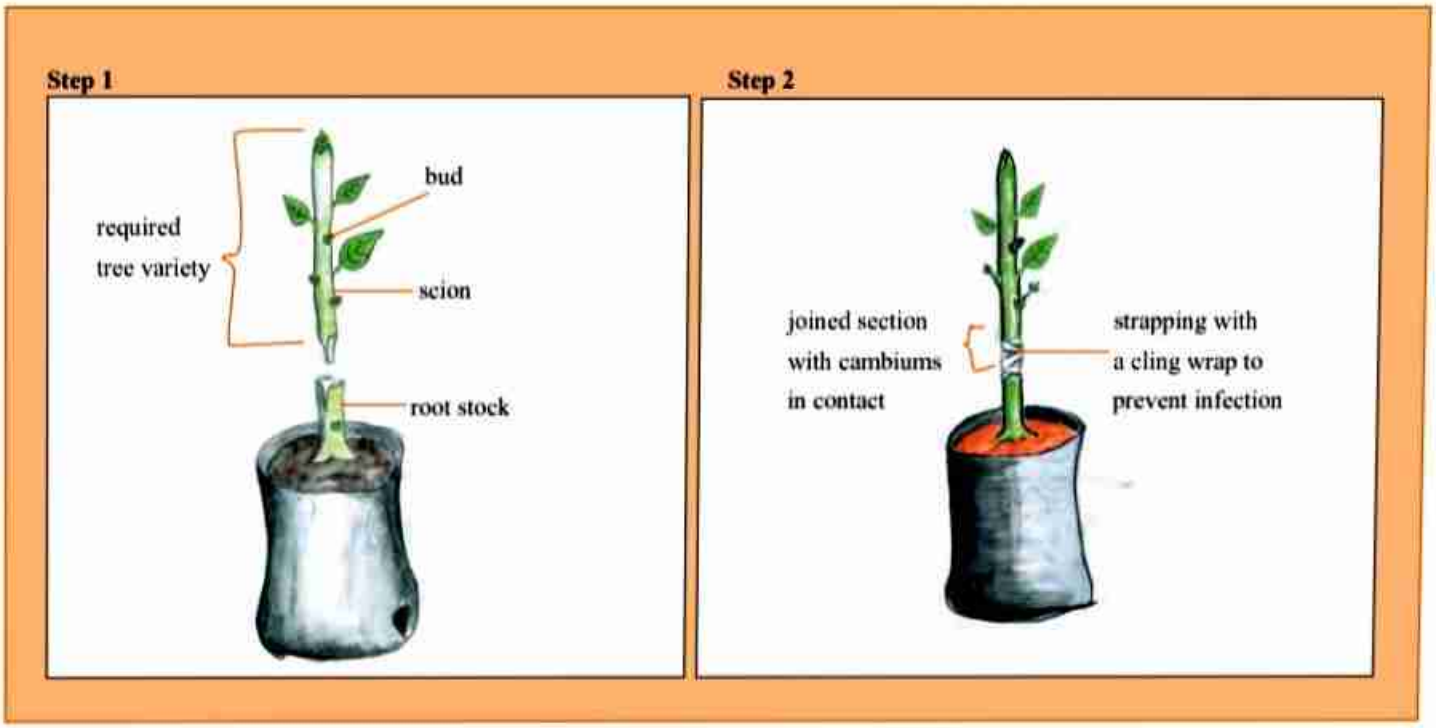


Fig. 4.23 Steps in cleft grafting

Budding

Budding is the joining of buds from desired plants onto another plant of the same species or family.

Most common method is the T budding where a **T**-incision is made on the root stock stem bark, peeling the bark slightly (outer skin). A scion or **V**-shaped cut section of the bud is inserted into the incision with the cambium of the root stock and scion in contact. Citrus trees and roses are multiplied through this method.

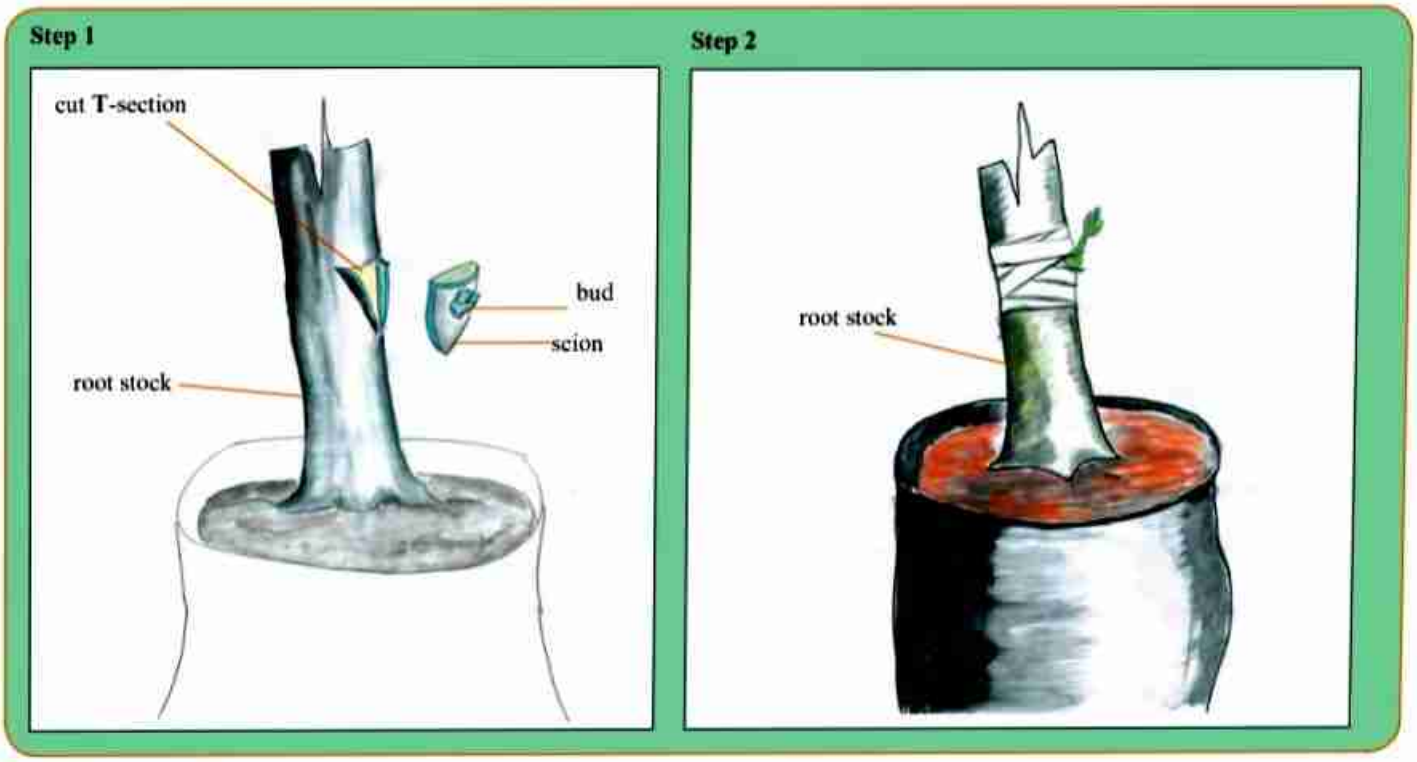


Fig. 4.24 Budding

Layering methods

Layering is a plant propagation method that creates conditions for root development on tree branches whilst they are still attached to the main plant. The branch with developed roots is later cut off and planted as an individual plant. Layering is mostly done in climbers and coffee plants. There are two types of layering methods, air layering and ground layering.

Air layering

This method involves inducing rooting on above ground plant branches. A plastic or cloth bag with soil is wrapped and tied around a bruised stem. The tied bag is watered frequently until roots develop. The branch with developed roots is then cut off and planted as a new plant.

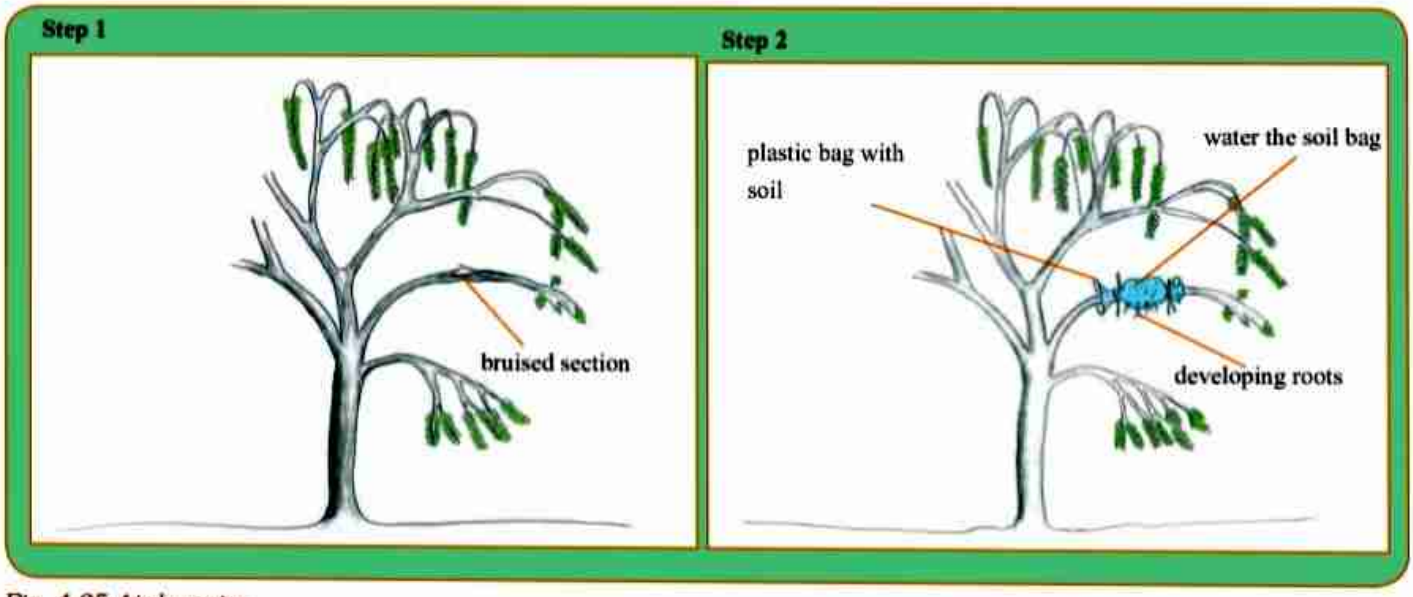


Fig. 4.25 Air layering

Ground layering

A healthy growing tree branch is slightly bruised and the bruised part is then pinned to the ground using a metal peg. The bruised area is covered with soil and is watered frequently to promote rooting. Once roots have developed the branch is cut off and established as a new plant.

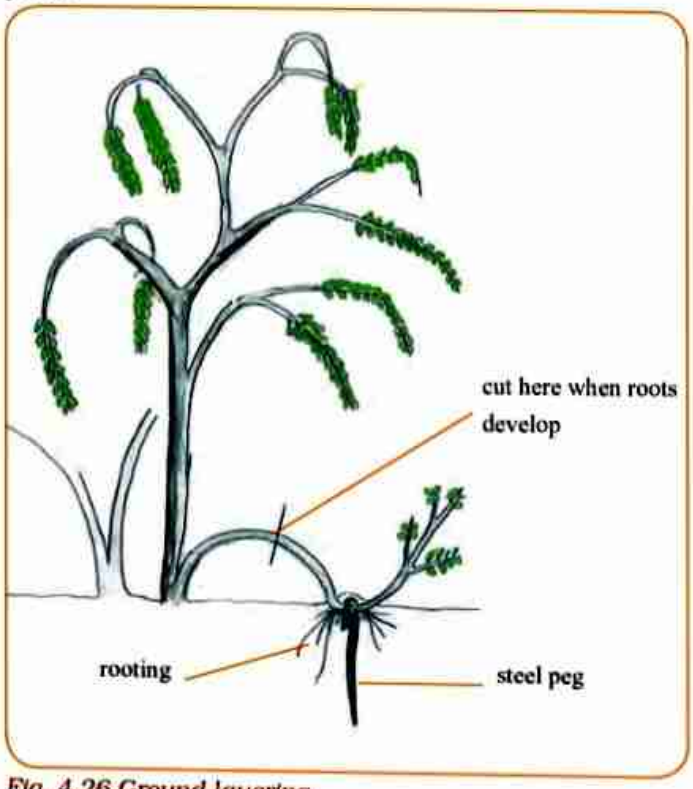


Fig. 4.26 Ground layering

Advantages of asexual reproduction

- Identical or true to type plants are produced.
- Fruit trees produced asexually mature or produce fruits in a shorter period.
- Desired characteristics are passed on to the next generation.
- Sterile plants can only be produced by asexual means.
- Vegetative parts have large food reserves that ensure successful establishment of new plants.
-

Disadvantages of asexual reproduction

- The method does not bring about variety as in sexual reproduction.
- Many plants cannot be generated quickly or in a short space of time.
- Some diseases or undesired characteristics are passed on to the new plant generation.
- Some vegetative parts may rot.
- The material used is very bulky and makes the process labour intensive.

Table 4.6 below gives a summary of the differences between sexual and asexual reproduction.

Table 4.6 Summary of the difference between sexual and asexual reproduction

Sexual reproduction	Asexual reproduction
• Involves male and female parts	• No male and female parts are involved
• Produces offspring different to the parents	• Offspring produced is identical to parents
• Process is slow	• Process is fast to establish new plants
• New plant is generated from the seed	• New plant is formed from parts of existing plants

Activity 4.6

Growing a plant using the asexual reproduction method

1. Collect at least ten different plants grown at your school and surrounding community.
2. Group them into sexually and asexual reproductive groups.
3. Choose one plant of your choice and grow it using any one method of asexual reproduction.
4. Manage the plant.

Germination

Germination is the development of seed into a new plant. The process is initiated when the right conditions are provided. Biochemical reactions will result in the development of the seed embryo into a shoot and rooting structure. Imbibition or entry of water into the seed through the micropyle initiates the germination processes. Swelling of the seed will break the seed testa, making way for shoot and root to break out.

Requirements for seed germination

For successful germination, certain conditions must prevail or must be provided by the farmer.

The following are necessary conditions for germination:

Water

Water or moisture is required to initiate the germination process and to break the testa. It is needed to moisten the seed. Water enters the seed through the mycropile and facilitates chemical reactions to take place inside the seed.

Oxygen

When seeds are germinating, they will be respiring, a process which needs air. Oxygen is required for respiration to take place, which supplies energy for the germination process. The soil should be well aerated to ensure the availability of air for the germinating seed.

Temperature

Seed germinating requires adequate or suitable temperatures to enhance chemical reactions taking place inside the seed. Low temperatures reduce or stop the germination process. On the other hand, very high temperatures may even kill the seeds.

Maize and bean seed structure

Structure of maize seed

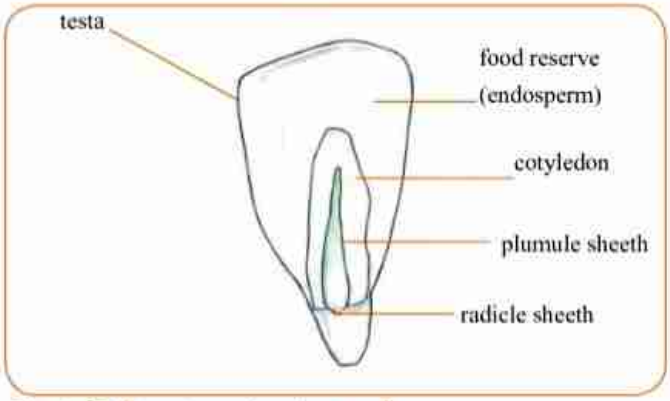


Fig. 4.27 Structure of maize seed

Table 4.7 Maize seed parts and their functions

Seed part	Function
Testa	• A tough and strong outer coating that protects the embryo.
Plumule sheath (coleoptile)	• Protects the growing point • First leaves burst out of the coleoptile.
Radicle sheath (coleorhiza)	• Develops into the rooting structure at germination.
Cotyledon **maize has only one cotyledon*	• First leafing structure at germination but only serves up until proper leaves are formed and start to photosynthesize. • Remains underground and absorbs food from endosperm supplying the actively growing tip.

Seed part	Function
Endosperm	• Stores food for the seed embryo. • Food store in endosperm provides energy for various processes that take place during the seed germination and emergency.
Micropyle	• A porous section on the seed, the section where seed was attached to cob. • Micropyle is the point of entry for water that is required during the germination process.

Structure of bean seed

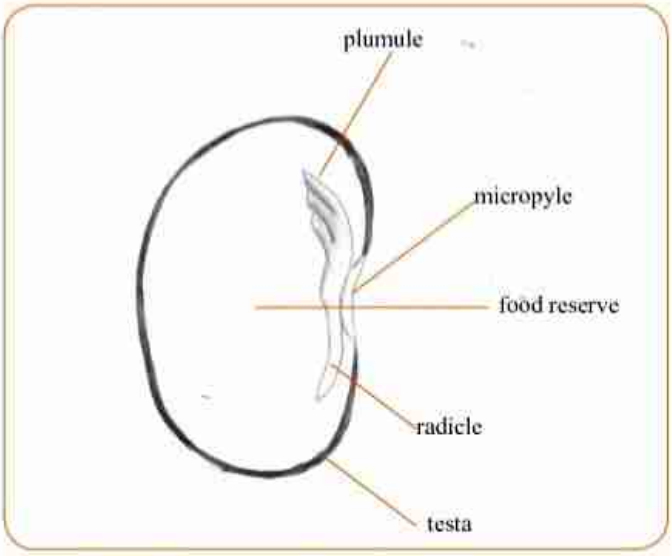


Fig. 4.28 Structure of bean seed

Table 4.8 Bean seed parts and their functions

Seed part	Function
Testa	• A tough and strong outer coating that protects the embryo.
Plumule	• Develops into new plant shoot at germination and emergency.
Radicle	• Develops into the rooting structure at germination.
Cotyledon	• First leafing structure at germination but only serves up until proper leaves are formed and start to photosynthesize.

Seed part	Function
Endosperm	• Food reserve for the seed embryo. • Food store in endosperm provides energy for various processes that take place during the seed germination and emergency.
Micropyle	• A porous section on the seed, the section where seed was attached to ovary. • Micropyle is the point of entry for water that is required during the germination process.

Activity 4.7

Dissecting maize and bean seeds

Materials: bean seeds, maize seeds, scalpel blades, magnifying glasses, white tile, beakers, distilled water.

Method

1. Soak maize and bean seeds in distilled water for 12 hours or a day before the experiment.
2. Place the seeds on a white tile.
3. Carefully split the seed into two sections.
4. Using a magnifying glass or lense, examine the seeds and identify the parts.
5. Draw and label the identified parts.

Experiment 2

Investigating requirements for seed germinatination

Materials:

20 bean seeds, 4 beakers (one with a lid), cotton wool, pyrogallic acid, filter paper

Procedures:

1. Label the beakers **A**, **B**, **C** and **D**.
2. Put 5 bean seeds in each beaker and then set them in different conditions as follows:
   - Beaker **A** - no water but has oxygen + suitable temperature
   - Beaker **B** - no oxygen but has water + suitable temperature

- Beaker **C** - water + oxygen + suitable temperature
- Beaker **D** - water + oxygen + low temperature

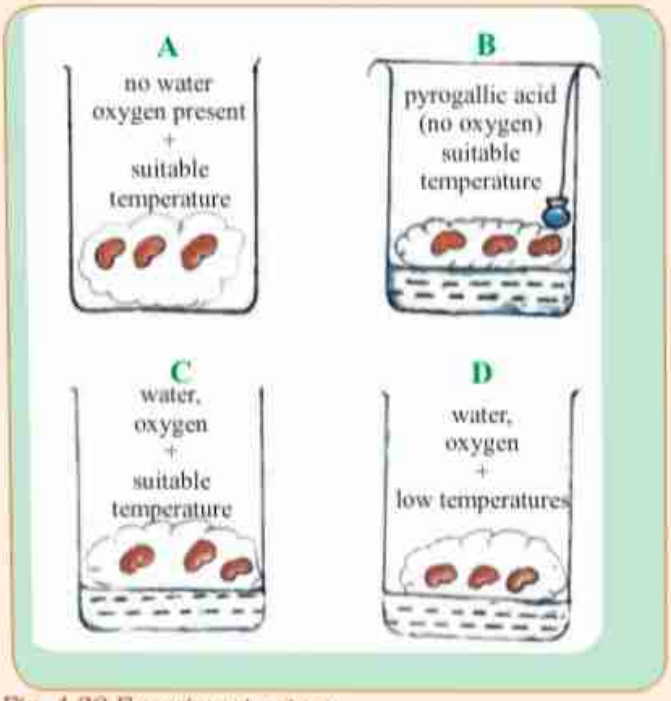


Fig. 4.29 Experiment set up

Observe what happens after a few days. Record your observations as below.

Observations:

- Beaker **A** _____
- Beaker **B** _____
- Beaker **C** _____
- Beaker **D** _____

Conclusion:

1. Explain briefly your observations.
2. Identify the conditions necessary for germination.
3. Explain the purpose of the pyrogallic acid.

Seed germination and emergence

When seeds are planted under favourable conditions, they shoot into new plants. This process where seeds develop into a new plant, is called germination. It takes place when the root tip (radicle) emerges from the seed coat (testa). Planting depth of seed has little effect on germination but affects emergence. Seed germination should not be confused with seedling emergence. Seedling emergence is the coming up of the seedling from the surface of the soil or water. Emergence entails the appearing of the seedling above the covering material. It should, therefore, be noted that seed germination involves development of seed embryo into a seedling. Emergence is the breaking out of the seedling or new plant from the ground.

germination

Fig. 4.30 A bean seed developing the root tip

seed emergence

Fig. 4.31 A bean seedling coming out of the soil

germination

Fig. 4.32 A maize seed developing the root tip

seed emergence

Fig. 4.33 A maize seedling coming out of the soil

Germination and emergency in maize and bean seeds

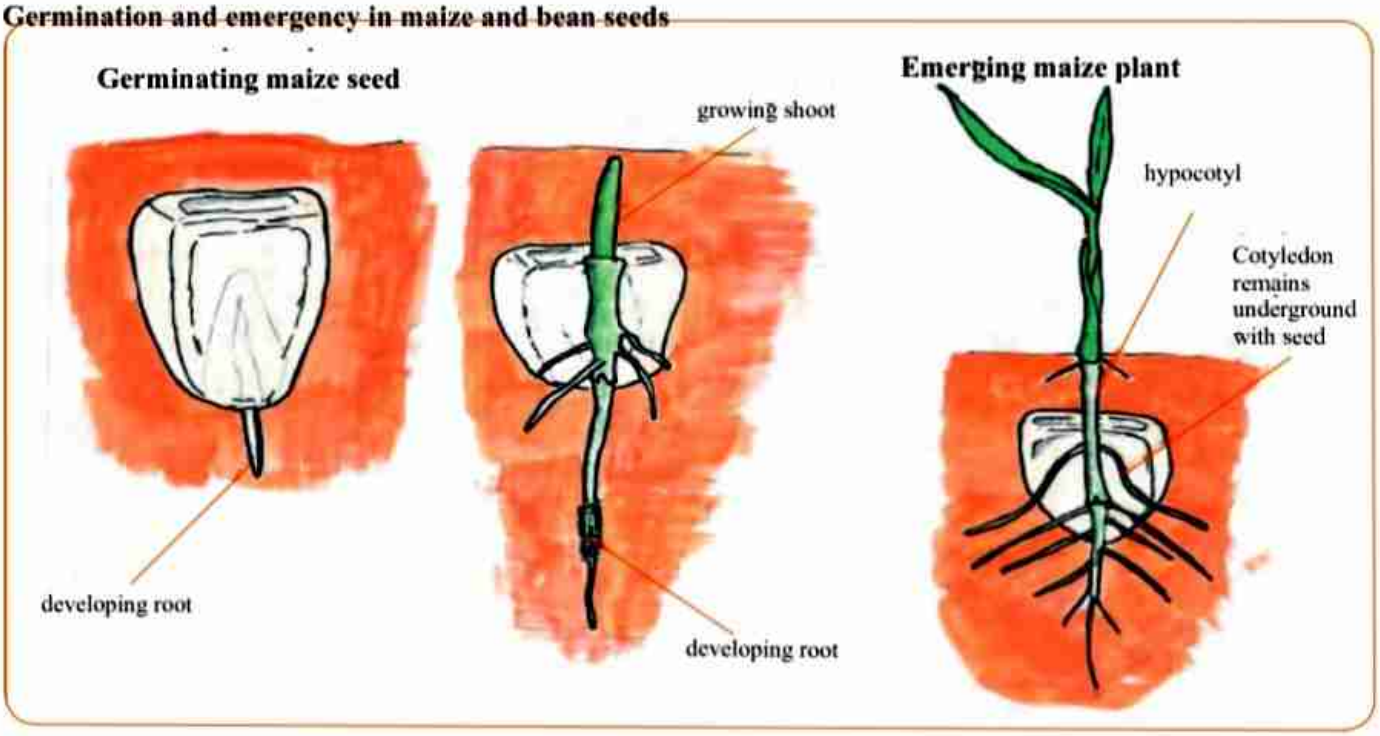


Fig. 4.34 Maize seed germination and emergence process

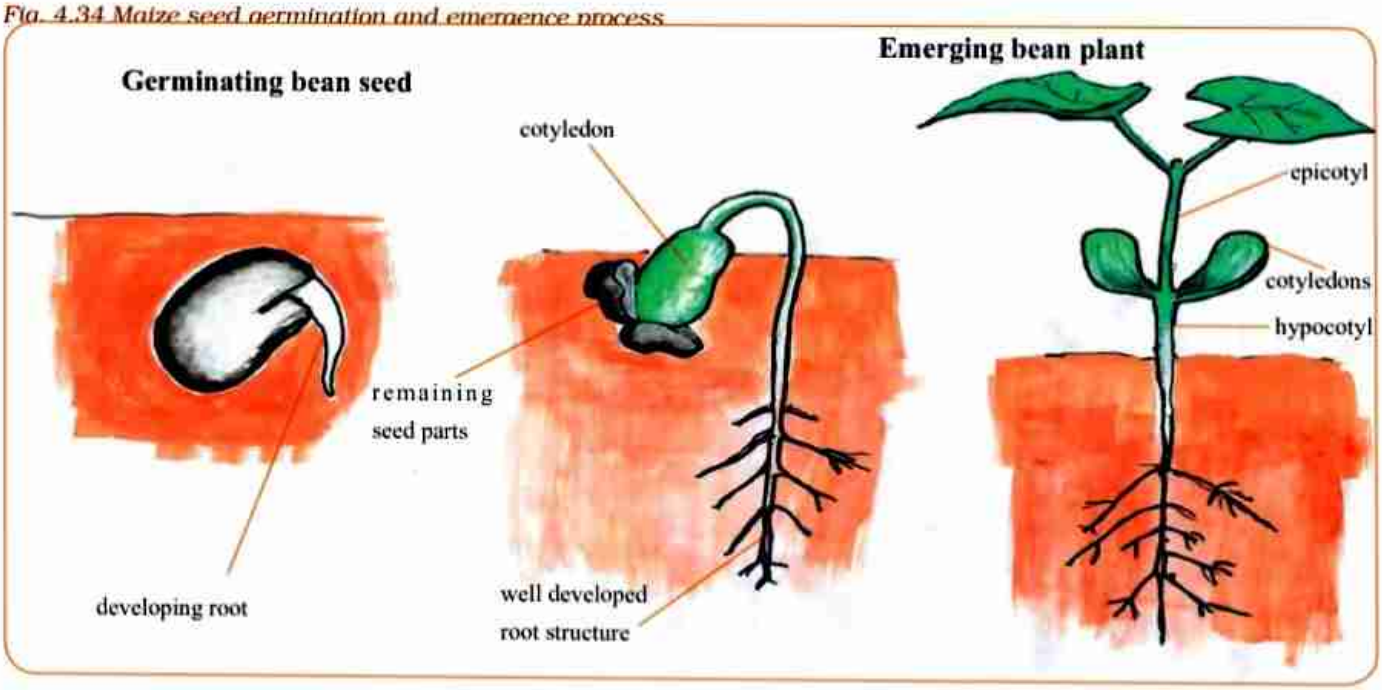


Fig. 4.35 Bean seed germination and emergence process

There are two types of germinations, epigeal and hypogeal germination. In epigeal germination, the cotyledons and seed remains are pushed out of the ground at emergence. Epigeal type of germination is common to most dicotyledonous plants, and a good example is the bean seed. However, this type of germination can be hindered by crusted soil and some seeds may have difficulties in emerging out of the ground. Monocotyledonous seeds do not undergo epigeal germination.

Hypogeal germination is a type of germination where the cotyledons and remaining parts of the seed remain underground as the shoot breaks out of the ground. This type of germination is common to monocotyledons and some dicotyledons. Such plants have less difficulties in breaking

Experiment 3

Investigating conditions necessary for germination

Aim: To find out if oxygen is necessary for germination

Apparatus/materials: conical flasks, wet cotton wool, small seeds, pyrogallic acid and sodium hydroxide

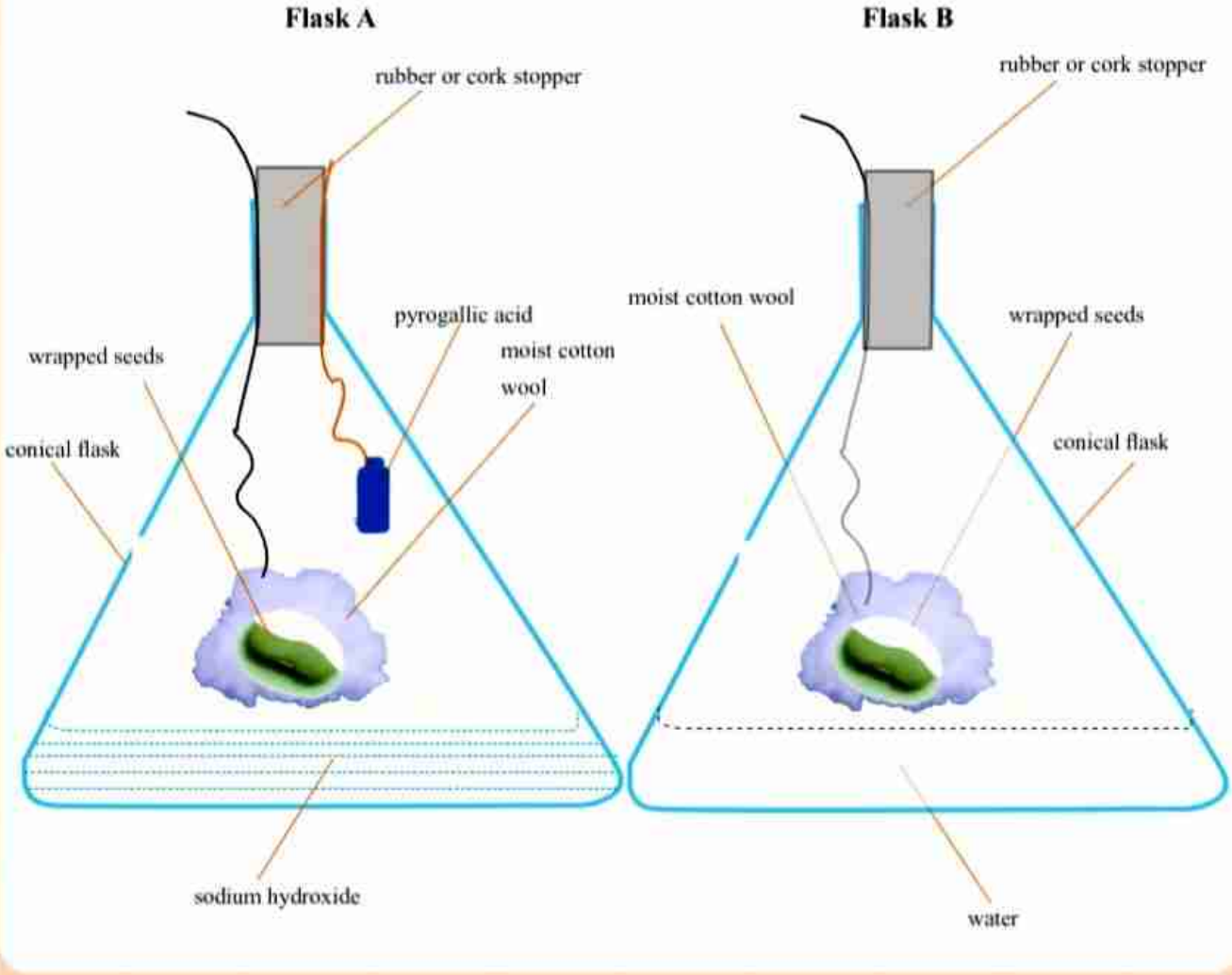


Fig. 4.36 Experimental set up

Procedure

1. Wet cotton wool and wrap some seeds in it.
2. Measure 30mls of pyrogallic acid and pour into a conical flask and label the flask **A**.
3. Add 20mls of sodium hydroxide to flask **A**.
4. Place the wet cotton wool with wrapped seeds into conical flask **A** and close the flask with a rubber stopper.
5. Label a second flask **B**. Measure 50mls of water and place it into flask **B**.
6. Place another wet cotton wool with wrapped seeds into flask **B** and close the flask wih a rubber stopper.
7. Leave the set up for some days whilst taking note of observations.
8. Record your observations.

Summary

- Plants are classified with physical similarities or biological relations.
- Monocotyledons are plants with single cotyledon in the seed and have narrow leaves with parallel veins.
- The flower is the main sexual organ in sexually propagated plants.
- Male parts of the flower are the anther and filaments.
- Female parts of the flower include the petals, stigma, style, ovary and ovules.
- Pollination is the transfer of pollen grains from the anther to the stigma.
- Pollination is very important for farmers as it determines the amount of yields especially in fruit production.
- Flowers are either wind or insect pollinated.
- Fertilization is the fusion or joining together of male and female nuclei.
- Asexual reproduction is the production of new plants from parts of existing plants without the involvement of the flower parts.
- Natural vegetative reproduction methods include propagation by plant organs such as corms, rhizome, stem tuber, solons and suckers.
- Artificial asexual reproduction methods are methods such as grafting, budding and layering.
- Germination is the development of the seed into a seedling.
- Seed emergence is breaking out of the new seedling from the ground.

Glossary

Asexual reproduction	:	the process where some plants multiply through the use of parental plant parts
Botanical classification	:	grouping of plants according to plant parts such as flowers, leaves, roots and stem
Bud	:	part of a plant that develops into a new plant shoot
Cambium	:	plant tissue that forms part of food transporting cells
Cotyledon	:	the first leaf structure of plants found inside the seed and at germination they provides food materials until proper leaves are formed
Dicotyledon	:	this is a plant with two cotyledons at emergence
Fertilization	:	the fusion of the male sex cells and female sex cells to form a zygote
Germination	:	process when the radicle develops into a root and the plumule into the shoot
Insect-pollinated flowers	:	these are plants whose pollination is done through the action of insects
Ovules	:	they are female sex cells of plants which develop into a seed after fertilization
Monocotyledon	:	plant with a single cotyledon at germination
Pollen grains	:	they are male sex cells which fertilize the ovule
Pollination	:	this is the transfer of pollen grains from the anther to the stigma of the flower
Propagation	:	making new plants
Rhizome	:	underground stems which can be used to multiply plants
Scented	:	producing a sweet smell
Sexual reproduction	:	this is the multiplication of plants through the use of a seed
Solanaceous plants	:	these are vegetables grown for their fruits, for example, tomatoes
Wind pollinated flowers	:	these are flowers which are pollinated by the action of wind
Zygote	:	a product of joining together of male and female nuclei

End of chapter questions

1. A plant with seeds containing a single cotyledon is classified as…
   A. dicotyledons B. monocotyledons
   C. broadleaved plants D. trees
2. Select a brassica crop from the following.
   A. cabbage B. tomato C. onion D. pepper
3. Which of the following lists comprise of legume crops?
   A. peas, rape, beans B. beans, peas, groundnut
   C. bean, peas, sunflower D. rape, bean, peas
4. Identify the method of propagating plants used in the diagram below.

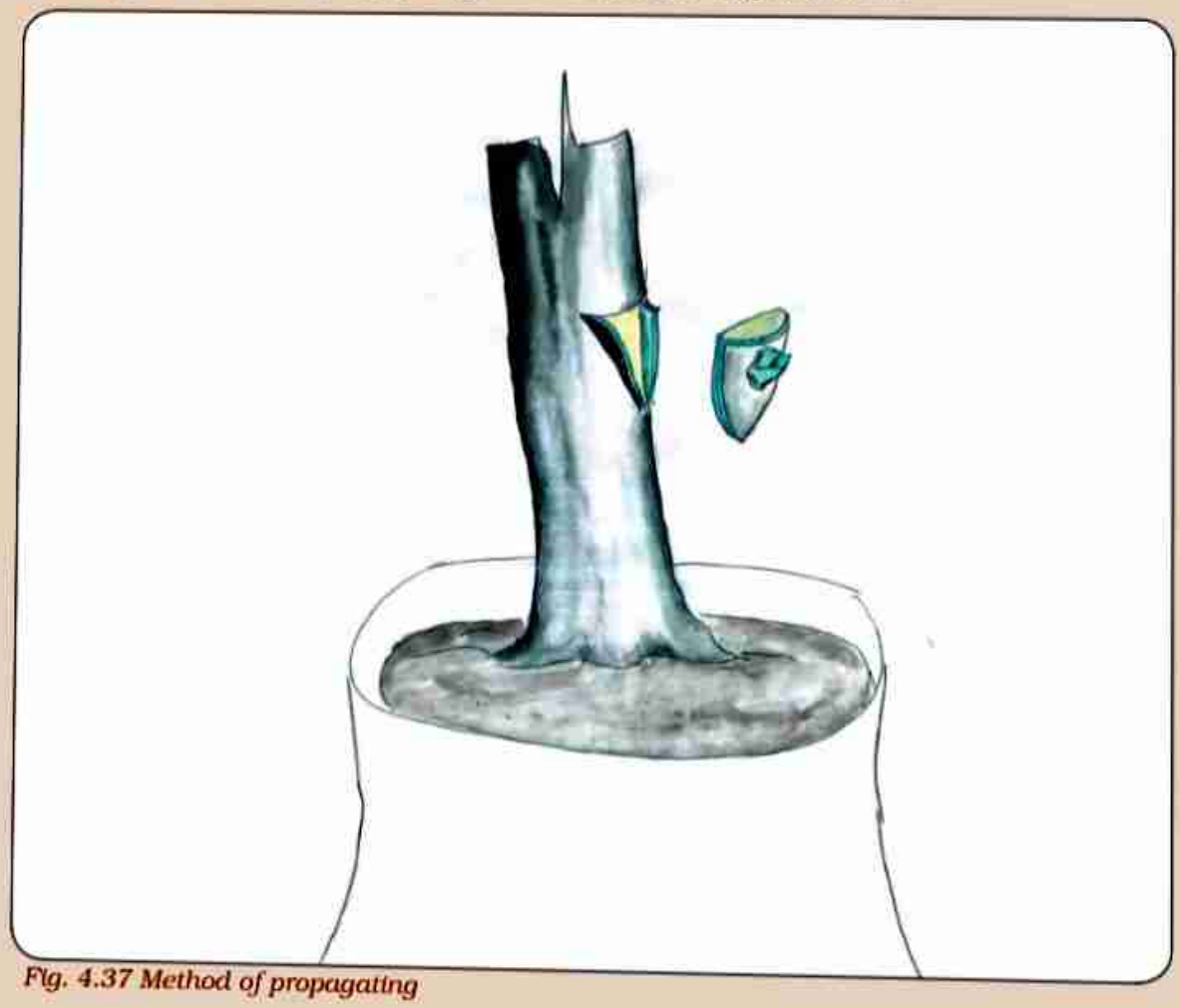


Fig. 4.37 Method of propagating

A cutting method B layering method C grafting D budding

5. What are the requirements for germination?
   A oxygen, water, fertilizer B oxygen, water, chemicals
   C oxygen, water, optimum temperature D oxygen, optimum temperature, fertilizer

6. Label the parts of a bean flower. [5]

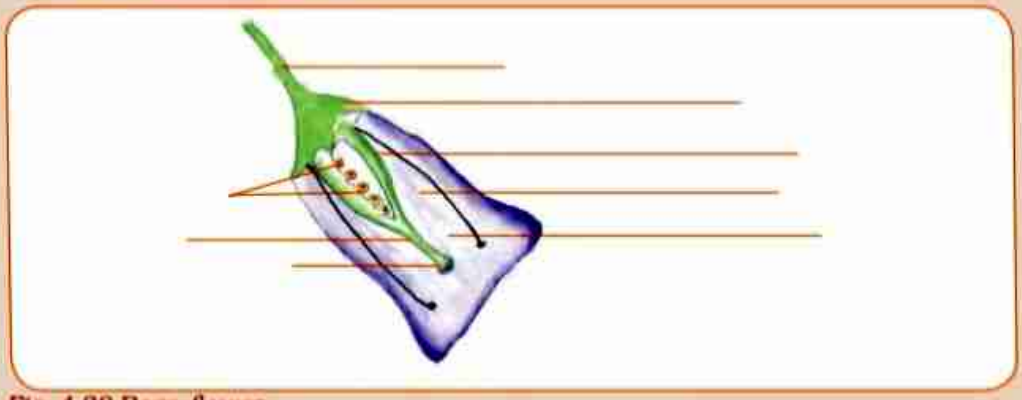


Fig. 4.38 Bean flower

7. Describe one artificial method of producing new plants. [4]
8. List 4 vegetative parts that can be used to generate new plants. [4]
9. Give the advantages and disadvantages of asexual reproduction. [5]
10. Write down the differences between sexual and asexual reproduction. [4]
11. Differentiate pollination from fertilization. [2]
12. Give the difference between germination and emergence. [2]
13. Label the maize flowering structures.

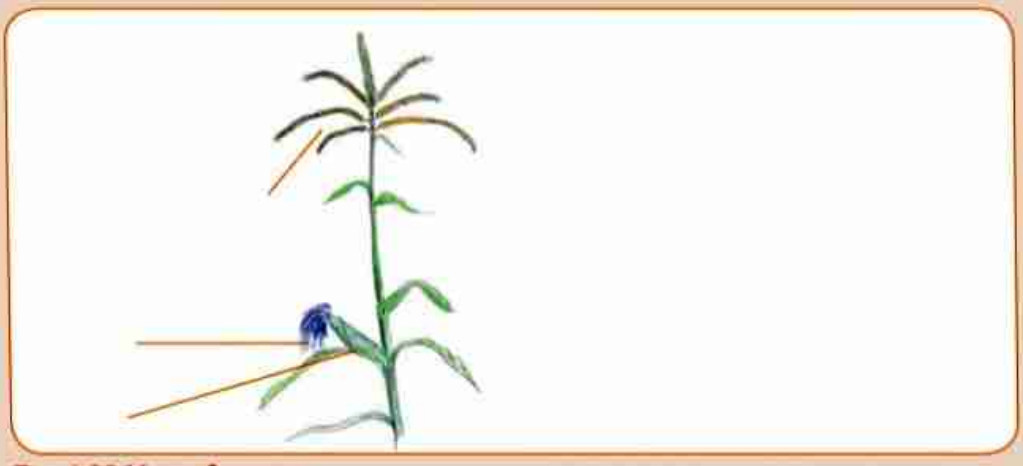


Fig. 4.39 Maize flowering

14. Define asexual reproduction. [1]
15. What is the function of the parts labelled X, Y and Z on the maize seed.

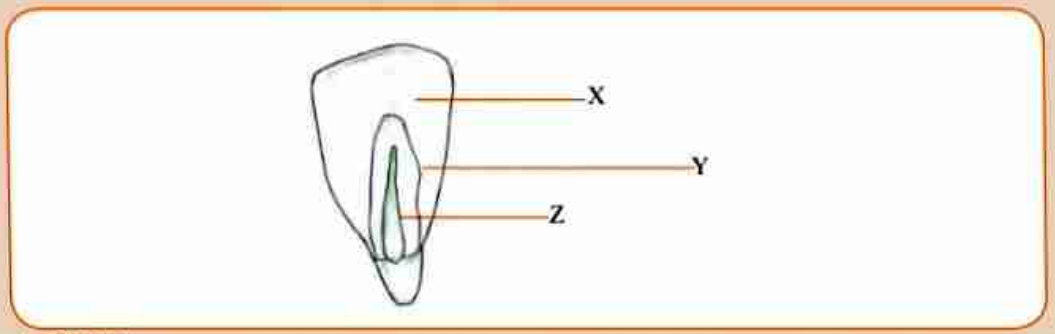


Fig. 4.40 Maize

CHAPTER 5 Crop production

Chapter objectives

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

- explain factors to consider when selecting a site for an orchard
- describe orchard land preparation
- explain the usefulness of different planting patterns
- peg planting stations
- prepare a planting hole
- plant fruit trees and calculate amounts of fertilizers required for orchard crops
- design an irrigation schedule
- discuss the reasons for pruning fruit trees
- prepare fire guards
- identify signs of fruit maturity
- market orchard fruits

Key concept

- Orchard establishment

Introduction

Fruit trees are plants that produce fruit. They are usually raised in containers in nurseries, after which they are planted out to permanent positions where they grow for production. Usually fruit trees are grown in orchards. An orchard is an area set aside mainly for raising fruit trees. Like any other crop, fruit trees require fertile soil which is deep and well aerated. Careful orchard management gives good fruit yields. Several planting systems or patterns can be adopted depending on the layout of the area, size of the area to be planted and the available labour at planting. These planting methods include, square, rectangular and staggered patterns.

Orchards need to be sited correctly on the most suitable and productive area. Farmers should make careful considerations when choosing a site for establishing an orchard. Fruit trees require proper management throughout their entire life. Good management results in good yields and fruit trees will last longer in production. Management practices carried out on orchard trees include fertilizer application, irrigation, pruning, protecting the trees and harvesting at the right stage of maturity required by the market. There are three classes of fruits grown in Zimbabwe, namely: citrus, subtropical and deciduous fruits.

Fruit produce should be sorted and packed according to size, colour or shape. Sorting out of produce into uniform grades of fruits is called grading. Marketing of fruits involves all efforts that are made to make potential customers aware and like the fruits available for sale. Farmers make money through sales. Marketing is therefore a very important factor determining how much a farmer sells. Strategies used in marketing should attract and make the public like the farm produce or fruits.

Orchard establishment

An orchard is an area of land set aside for fruit production. A variety of fruit trees can be planted in the same area or orchard. An orchard is different from a fruit plantation in which one type of fruit trees is planted in the whole area.

Factors which influence site selection of an orchard

There is need for a farmer to choose an appropriate site for an orchard, with conditions that will help growth of the trees as well as making it easy to manage the orchard. The following are some of the factors to consider when establishing an orchard.

Soils: Fruit trees need deep, fertile and well drained soils. In some cases, soil may need to be treated to get rid of soil-borne diseases and nematodes that may affect the trees.

Water: Water is essential for plant growth. Fruit trees require water. During dry seasons trees may need to be watered (irrigation). Therefore, an orchard should be near a reliable source of water.

Pests and diseases: Like any plant, orchard trees may be affected by pests and diseases. An orchard should therefore be in areas which are not heavily affected by particular pests and diseases.

Climate: Climatic conditions such as rainfall, temperature, sunshine wind and humidity have a strong bearing in fruit production. For example, too low temperatures may cause frost bites to fruits or strong wind may break fruit trees. Some fruits such as peach require low temperatures for them to flower.

Transport and market: Fruits are perishable. Though modern transport can ferry fruits in refrigerated trucks, it is always advisable to locate an orchard near transport and market. An orchard must be easily accessible.

Land preparation

Operations done to the soil before establishing an orchard depend on the number of trees to be planted. It is, however, very important to first take soil samples for tests to determine nutritional status of the soil and most suitable fruit trees. Using results from soil tests, correct liming and fertilizer application can be done by the farmer.

Where a few trees are to be planted, a farmer only pegs planting stations and digs out the planting holes needed. When establishing an orchard where a good number of fruit trees are to be planted, the land needs to be ploughed first. Ploughing should be done when soils are not too wet or too dry as this destroys the soil structure. The land is levelled after ploughing. The degree of levelness depends on the type of irrigation to be used. Flood irrigation methods require a high degree of levelness.

Marking out planting stations

Planting stations or positions should be marked well before planting the fruit trees. The right tools are required to come up with correctly positioned planting stations. The following tools are needed:

12-meter piece of rope, a measuring stick 2,5metres long, a rope of length equivalent to the longest side of the orchard plot. The piece of rope should be knotted at 3-metre and 4-metre lengths.

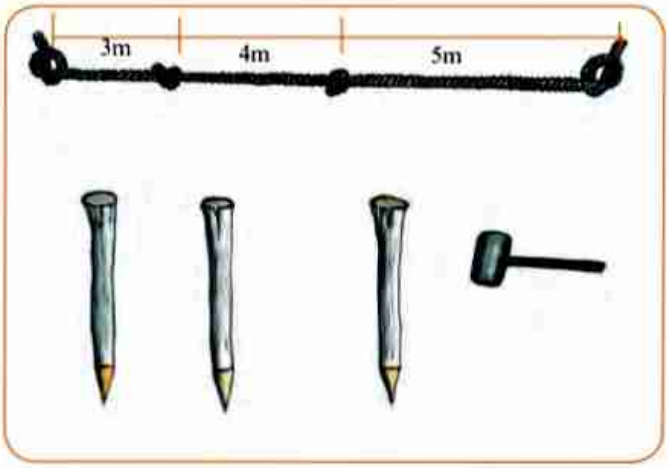


Fig. 5.1 Materials for marking out planting stations

Marking out the square pattern (pegging)

- A base line is marked by pulling the rope along one side of the area; a metre from the fence. This baseline is marked along the rope on the ground.
- Use the 12-metre long rope knotted to make segments on 3-metre, 4-metre, and 5-metre knots on one end of the base line until a right angle is marked by the 3-metre and 4-metre piece of ropes. Tie along the rope to mark the angle on the ground.
- Take a 2,5-metre stick and measure the length along the base line or the angle line. Holes are dug with a hoe at 2,5-metre marks as shown in Figure 5.2 below.
- The rest of the planting station are marked by moving the rope to each hole along the base line. Using the measuring sticks, holes are dug 2,5metres apart along each line.

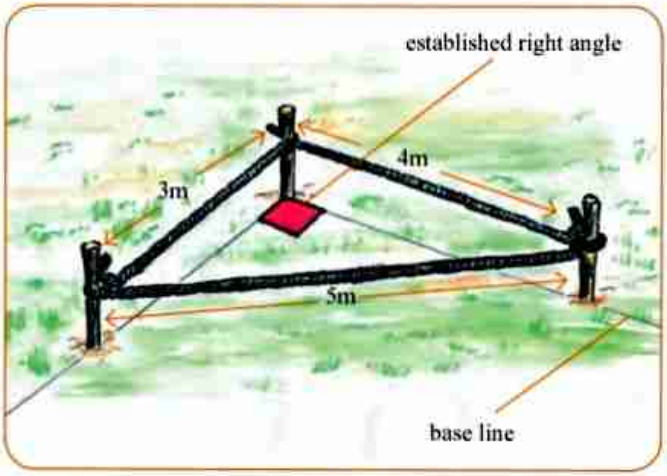


Fig. 5.2 Illustration of 3-4-5 method

The square pattern

This is a planting pattern that maintains the distance between rows and within rows. The method allows free operational movements in different directions as required.

Fig. 5.3 Square pattern

The rectangle pattern

The rectangle pattern is like the square pattern. The only difference is that the in-row spacing or distance between trees in a line is made greater than the inter-row space (distance between planted tree lines).

The same method for marking out the square pattern is used to get the rectangle planting pattern. The only difference is that a 3-metre long stick will be used in place of the 2.5-metre stick.

Fig 5.4 Rectangle pattern

The staggered pattern

The staggered method is more complex than the method of square or rectangle patterns. The staggered method gives each tree more space. Staggering method does not follow a regular pattern.

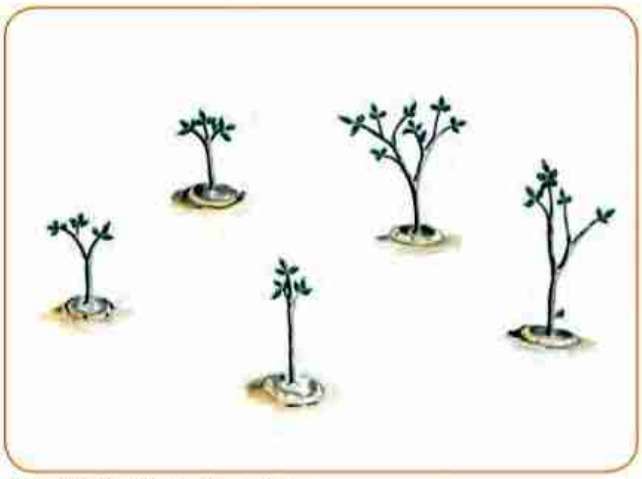


Fig. 5.5 Staggered pattern

Digging planting holes

Fruit trees are usually planted in bigger containers. Deeper planting holes are needed for fruit trees. Square holes measuring 60cm long, 60cm wide and 60cm deep are dug as shown in Figure 5.6 below.

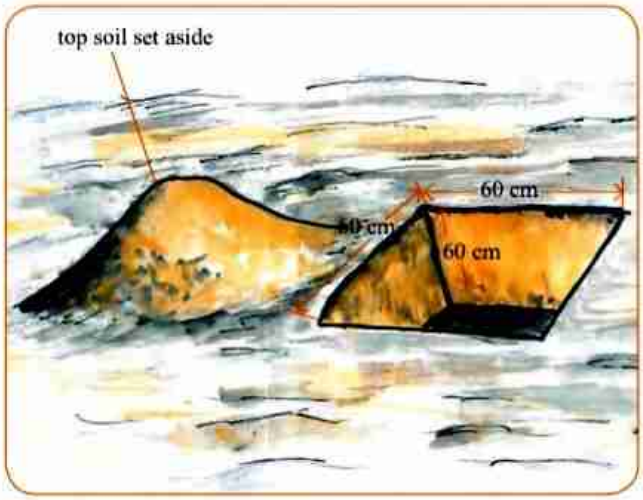


Fig 5.6 A square planting hole

Stages when digging a planting hole

1. Dig the top 30cm of soil and put it on one side of the hole.
2. Dig out the bottom 30cm of soil and put on the other side of the hole.
3. Loosen the soil at the bottom of the hole.
4. Mix the topsoil with the compost, half of the bottom soil and 500g of SSP (Single Super Phosphate fertilizer).
5. Use the mixture to fill the hole and construct the basin around the edge of the hole using the subsoil.
6. Finally, add 300 grams of compound D fertiliser and water the hole.
7. The hole is then ready to receive the plant.

Planting board

A wooden board, called a planting board, is used to make sure trees are planted in the correct place. Usually the board is 150cm long and 15cm wide in size. The planting board ensures that a straight line and correct depth of planting is maintained.

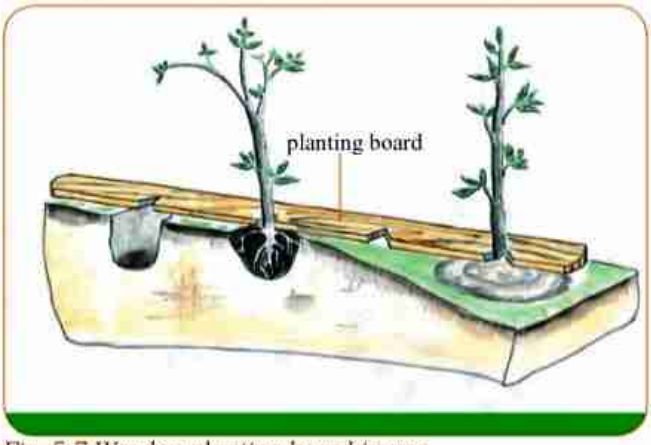


Fig. 5.7 Wooden planting board in use

Activity 5.1

Field survey

1. Find out families or farms with orchards and establish factors that could have influenced the choice of their orchard sites.
2. In groups, carry out a survey in the surrounding community to find out the types of fruits commonly grown in the area.

Activity 5.2

Preparing planting stations

Prepare a planting station in the school orchard following the procedures discussed in this chapter and plant a fruit tree of your choice

Classification of fruit trees

In Zimbabwe, fruit trees are classified into three broad groups which are:

- Citrus
- Subtropical
- Deciduous

Citrus fruit trees

These are fruit trees which are evergreen and spiny. Their leaves are scanted and are oily. Their fruits are thick-skinned and produce a juicy flesh with a sour or sweet taste. Examples of such fruit trees include lemons, oranges, naartijie and lime. Citrus fruit trees do best in areas such as Beitbridge, Chiredzi and Mazowe valley.

Fig. 5.8 Some common citrus fruits grown in Zimbabwe

Deciduous fruit trees

These are fruit trees which do best in frost free areas. Usually deciduous fruit trees lose their leaves in winter and remain dormant. Examples of such trees include, apples, peaches, pears, apricots and nectarines.

Fig. 5.9 Some common deciduous fruits grown in Zimbabwe

In Zimbabwe, deciduous fruit trees are commonly grown in the Eastern Highlands where climatic conditions of high rainfall and cool temperatures are very conducive.

Subtropical fruit trees

These are fruit trees which do best in warmer areas and are affected by frost. Most of these subtropical fruit trees are sensitive to frost when they are still young. Once grown, they tend to be frost tolerant. The most common subtropical fruit trees include:

- Avocado pear
- Bananas
- Pawpaw
- Mango
- Pineapple
- Granadilla

In Zimbabwe, subtropical fruit trees are mostly grown in the Eastern Highlands.

Fruit production and management

Peach production

Peach trees are deciduous trees which usually lose their leaves in winter. Usually they remain leafless or dormant after shading their leaves until the weather changes. In Zimbabwe, peaches are mostly grown in the eastern highlands because they require cool temperatures for them to flower. Flowering and subsequent pollination greatly influence the amount of harvest.

Peach cultivars

There are many peach cultivars which are grown in Zimbabwe. These include Rhodes, Back Aries, Jubilee, Golden dawn and Early amber. These cultivars vary in terms of colour size, flower and taste. Most of the peach cultivars have red skin, whitish flesh and are medium sized. These include Supreme and Golden dawn.

Fig. 5.10 Some peach cultivars

Propagation

Some farmers usually propagate peach trees through the use of seeds. However, the most common methods of propagating peach trees are grafting and budding. Grafting and budding have the advantage of producing identical fruit trees. This means desired characteristics are maintained, uniform fruit is produced and this is very important in establishing markets.

Planting

Before planting, land should be deeply ploughed to enhance aeration, percolation and water holding capacity. The planting season is usually late June and mid-July. To improve soil fertility, lime and fertilizers should be incorporated into the soil before July or before planting.

Planting holes 100mm wide and 600mm deep are dug and a mixture of 4kg manure and 700g of single super phosphate is added to the top soil and used to fill up the hole. Usually planting is done using a planting board 150cm long and 15cm wide.

Fertilizer requirements

Top dressing with 300g of ammonium nitrate per plant is required. Peach trees require a number of trace elements for successful growth and production. These trace elements include boron, manganese, zinc and copper. Trace elements are nutrients required in small amounts and should not be applied regularly but at least once a year.

Pruning

This is a management practice that involves selective removal of some tree branches for many reasons. Pruning saws or sharp cutting machetes can be used to cut the tree branches. Reasons for pruning fruit trees are:

- pruning promotes new growth and rejuvenates old trees
- to get rid of unproductive old and dead tree branches
- removal of some branches helps to upgrade fruit quality
- pruning improves flowering and fruiting
- shaping the tree
- preventing some tree branches from touching the ground.

Pruning is done in winter or autumn. This is because the trees will not lose a lot of sap. Most fruit trees will be dormant during this period.

Pests and diseases

Peaches have few problems when it comes to pests and diseases. However, fruit flies are common pests and

are controlled using Malathion. Aphids also affect the peach plant and can be controlled easily using aphicides. Powdery mildew is the most common disease of peaches. Powdery mildew is a fungal disease that can be controlled using copper based sprays or fungicides.

Harvesting and marketing

After five years and more, peach trees start bearing fruits. Depending on the management practice, about 50kg of fruit per tree could be harvested. The fruits are very nutritious and are a good source of vitamins. Usually, harvesting is done by hand. Peaches should be marketed whilst fresh and are suitable for both local and foreign markets. Generally, peaches are packed in well ventilated crates to keep them fresh and maintain taste. Alternatively, peaches can also be dried and marketed as dry fruits.

Banana production

Bananas are subtropical fruits which are sensitive to frost and grow best in frost free areas. However, when grown to maturity, they tend to be frost tolerant.

Banana cultivars

There are only two major cultivars of bananas, namely:

- Cavendish: these have a maximum stem height of 1,2 metres
- Lady finger: these have a stem height of 3,5 metres

Fig. 5.11 Banana cultivars

Propagation

Usually bananas are grown from suckers which are found on the main plant. They do best when planted near soak ways.

Banana suckers can be grouped into three categories which are:

- Maiden suckers
- Sword suckers
- Water suckers

Planting holes should be 45cm wide and 45cm deep and spaced 3 metres by 2 metres apart. However, this depends on the variety and prevailing climatic conditions.

Fertiliser requirements

Bananas are heavy feeders hence they require plenty of fertilisers. A mixture of 1kg compound D fertiliser, 1kg lime and 40kg well-rotten manure is mixed together with soil and used to fill the planting hole. A 280g muriate of potash and 500g ammonium nitrate is applied as booster nutrient. This is usually done at the end of the rainy season.

Pruning

Established bananas need monthly removal of unwanted suckers (desuckering). Only three desired plants are allowed to grow. Pruning is done to ensure that those plants left to grow get enough food since a banana plant is a heavy feeder (requires a lot of nutrients).

Pests and diseases

There are a number of pests and diseases which attack bananas. Soil pests like nematodes are the main problems in banana growth. Stems and roots of bananas are most affected by pests. Usually planting units need to be treated with Nematicides, a chemical for controlling nematodes.

Harvesting and marketing

When ripe, bananas have a very low shelf life. They therefore need to be harvested green and then ripe while in storage. If meant for distant marketing, they are transported while green in well ventilated crates.

Orange production

Oranges fall in the family of citrus fruits. They are subtropical fruit trees which do not shed their leaves in winter. Oranges have an orange skin when ripe and have a juicy flesh with a sour sweet taste. In Zimbabwe, oranges do best in areas such as Mazowe valley, Chiredzi and Beitbridge.

Orange cultivars

The most commonly grown orange cultivars in Zimbabwe are Premier late, Valencia, Washington, Navel and the Mediterranean sweet.


navel oranges


valencia oranges

Fig. 5.12 Orange cultivars

Soil and climatic requirements

Oranges, like all other citrus fruits, require warm temperatures and frost free climatic conditions. Deep and well drained soils promote a good orange crop stand. Top soil should be mixed with single super phosphate (SSP) at planting. A nitrogen fertilizer plus potassium are incorporated into the soil at flowering and at fruiting stage.

Propagation

Most of the orange cultivars do not produce viable seeds. This makes it very difficult to propagate oranges using the seed.

The most suitable propagation method is the budding method.

Fig. 5.13 A budded orange tree

Planting oranges

Planting of oranges is best done during the rainy season. In Zimbabwe, oranges are planted between January and February when there is plenty of rainfall. Planting during the rains helps the plants to establish more successfully. However, some people start planting orange trees as early as November to lengthen the period of establishment. This in turn reduces the need to water the plants during the dry season.

Planting is done in holes measuring 60cm x 60cm and 45cm deep. Planting holes are spaced at an in-row spacing of 3,6 metres and an inter-row of 4,3 metres.

Pruning

Oranges are not commonly pruned. However, if pruning is done, it is carried out to remove dead and diseased branches.

Pests and diseases

Oranges are attacked by a number of pests and diseases. The most common pests include citrus thrips, ants and fruit flies. Malathion 25% WP and dipterex are the most commonly used pesticides to control pests in citrus fruits.

Diseases which affect oranges are seals, greening, root rot and black spot.

Harvesting

When mature, oranges change colour from green to orange and begin to soften. Oranges are usually harvested using hands.

After harvesting, oranges are graded and packaged into pockets which are well ventilated. Those which are small are usually kept for crushing and extraction of juice.

Fig. 5.14 Harvesting process

Basin making

A basin is a constructed depression around a tree to accommodate water for the growth of the tree. Every tree should have a well-constructed basin to hold water, fertiliser and compost for the plant. The diameter of the basin should be equal to the canopy of the tree.

Fig. 5.15 An irrigation basin

Watering of fruit trees

Fruit trees require irrigation especially in winter when there is inadequate rainfall to maintain the trees in production. High temperatures require frequent watering as evaporation losses are high. Soil type determines frequency of watering. Sandy soils require frequent watering because sandy soils have poor water storage capacity. Available amount of water and type of the source of water influences the method of irrigation.

Activity 5.3

Managing fruit trees
In pairs:

1. Construct a basin around the fruit trees in your school orchard.
2. Identify fruit tree branches that need to be removed and cut them off.
3. Record your activities including tools used.

Activity 5.4

Harvesting and preparing fruits for the market

1. Harvest ready fruits from your school orchard using the correct indicators of growth.
2. Prepare the fruit for marketing.
   This should include:
   - cleaning
   - grading (sorting according to size)
   - packaging
   - weighing
   - pricing
   - marketing strategy
   - recording the harvest weight and expected income

Activity 5.5

Designing an irrigation system and schedule for fruit trees

1. Design an irrigation system and schedule for your school orchard.
   This should include:
   - types of irrigation you are going to use
   - source of water
   - amount of water you need per plant
   - frequency of watering (irrigation)
   - Monitoring the irrigation system
2. Write down the factors that influenced the choice of your irrigation system.

Summary

- An orchard is a place where fruit trees are grown.
- Before establishing an orchard, site factors such as soil, water, pests and diseases, climate conditions, transport and easy of access to market need to be considered.
- Soils for areas sited for orchards should be taken for tests to determine their nutrient status.
- Land for fruit trees is prepared by cultivation, pegging plant stations and marking planting holes.
- Planting stations are marked out using the 3, 4, 5 method to make right angles at 90^0.
- Orchard fruit trees are planted using a number of patterns such as square pattern, rectangle pattern and staggered pattern.
- Once trees are planted, they need to be taken care of until they are harvested. This includes fertilising, watering, scouting for pests and diseases, pruning and making fire guards.
- Major fruit classes grown in Zimbabwe are citrus, deciduous and subtropical fruits.
- Citrus fruits include orange, lemon, lime and nartjie.
- Deciduous fruits are fruits such as apples, peach, pear and apricots.
- Subtropical fruits grown in Zimbabwe include avocado pear, banana, paw paw, mango and granadilla.
- Fruit trees should be pruned to improve production and lengthen the productive period.
- Different fruit trees show different signs of maturity, and once they are mature, they need to be sold quickly.
- Harvested fruits should be cleaned, graded, weighed and packaged in branded (labelled) packs.

Glossary

Basin:	is a depression formed around a fruit tree to keep the water, manure, mulch, and fertiliser available for plant roots
Budding:	is a vegetative plant propagation method where a bud is united to a root stock of a desired fruit tree to improve its quality
Citrus fruit trees:	are fruit trees which do not shade their leaves in winter, for example orange trees
Deciduous fruit trees:	are fruit trees which shade their leaves in winter, for example peach, apple and pear trees
Nematicides:	are chemicals used to control nematodes
Orchard:	is place where fruit trees are grown for their fruits
Primary tillage:	is a land disturbance using heavy implements like the mouldboard plough or disc plough
Secondary tillage:	is a land tillage where light tools are used such as rakes or hoes

End of chapter questions

1. Land preparation means:
   A. Making the land suitable for planting
   B. Planned distribution of soil
   C. Marketing the farm products
   D. Locating an area without water
2. Which fruit list correctly identifies subtropical fruits?
   A. Banana, avocado pear, granadilla
   B. Orange, naatilie, apple

C. Banana, apricots, lime
D. Peach, apple, pear

3. Which of the following fruit could be put under citrus fruits?
   A. Apples
   B. Pears
   C. Apricots
   D. Naartijies
4. Of the following types of fertilizers, which one can be used as top dressing in plants?
   A. Ammonium nitrate
   B. Single super phosphate
   C. Compound D fertilizer
   D. Quick lime
5. For successful growth and establishment, oranges need to be propagated through which of the following methods?
   A. Layering
   B. Grafting
   C. Rhizomes
   D. Budding
6. What is the use of a planting board?
   A. Placing seedlings
   B. Maintaining planting depth and maintaining straight lines during planting
   C. Making planting patterns
   D. Measuring planting stations
7. Oranges are usually planted in January but some can be planted as early as in November because:
   A. November is the hottest month
   B. oranges planted in November are very sweet
   C. it helps to improve fruit size
   D. it helps to avoid or minimize supplementary watering at dry spells
8. a) Briefly describe how you would prepare land for planting a named fruit tree. (5)
   b) Give two reasons why it is necessary to prepare land before planting a tree. (4)
9. Explain factors that are considered when siting an orchard.
10. An area of 10 hectares is to be planted with oranges at a spacing of 2.5 metres by 3 metres. Work out the plant population of this orchard. (4)
11. Using a diagram, illustrate budding of an orange fruit tree. (4)
12. Describe the stages one should follow when planting a named fruit tree up to the harvesting of the fruit. (8)
13. a) How would you prepare a named fruit for the market after harvesting? (4)
    b) What factors would you consider before you price your fruits for the market? (3)
14. For a named fruit tree crop, discuss its soil and fertilizer requirements. (4)
15. Name the classes of fruit trees grown in Zimbabwe. (6)

CHAPTER 6 / Crop protection

Chapter objectives

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

- describe the complete metamorphosis and incomplete metamorphosis life cycle of pests
- describe how plant diseases are spread
- identify symptoms of named groups of diseases
- explain the dangers caused by diseases to plants
- classify weeds as grasses, sedges and broad-leaved
- identify the mode of spread of common weeds

Key concepts

- Pests
- Diseases
- Weeds

Introduction

In agriculture, crop production can be under a serious threat from pests, diseases and weeds. Pests, diseases and weeds are the most common crop enemies that can hinder crop production. Bad weather elements such as extreme coldness and extremely high temperatures are also devastating to crops. Farmers need to protect their crops from these crop enemies. Pests destroy plant parts or whole crop. Diseases can reduce plant growth, yields and in some instances, kill the plant. Crop weeds or plants that grow where they are not needed disturb plant growth significantly, thereby, reducing yields. It is important for farmers to be aware of pests, diseases and weeds that affect their crops.

Plant protection discussed in this chapter helps in understanding the various plant pests, weeds and diseases. In plant protection, farmers should know the dangers caused by the crop enemies, how they spread and the measures to put them under control. Studying insect life cycles helps in identifying the insect developmental stages that are destructive to crops. It also helps to craft methods of controlling pests at the most effective stage of their development. Without proper crop protection, agriculture production will be greatly reduced and will be under serious threat.

Plant pest

A pest refers to any organism harmful to plants. This can also include people and their activities. Most pests are insects while others are animals such as monkeys, rats, birds and baboons. Some pests can be easily seen with naked eyes while others are very tiny (microscopic) and can only be seen using powerful microscopes. Pests are classified or grouped according to the type of damage they cause to crops.

Each class of pests attack a particular type of crop family. For example, eelworms seriously attack root crops while red spider mites attack tomatoes, potatoes and all solanaceous crop family.

Most insect pests reproduce through laying eggs. Insects develop through a number of stages undergoing body changes. This is known as life cycle. The life cycles of insects can be in two forms, complete metamorphosis or incomplete metamorphosis.

Insect life cycles

Complete metamorphosis

Complete metamorphosis is a life cycle which follows four distinctive stages of development, which are egg

stage, larva stage, pupa stage and adult stage. In complete metamorphosis, an insect goes through complete changes in body shape and structure as it develops from the egg stage to an adult insect. Examples of such pests with four distinctive stages of their life cycles are butterflies, moths, beetles and fruitflies. Figure 6.1 shows an illustration of a life cycle undergoing complete metamorphosis.

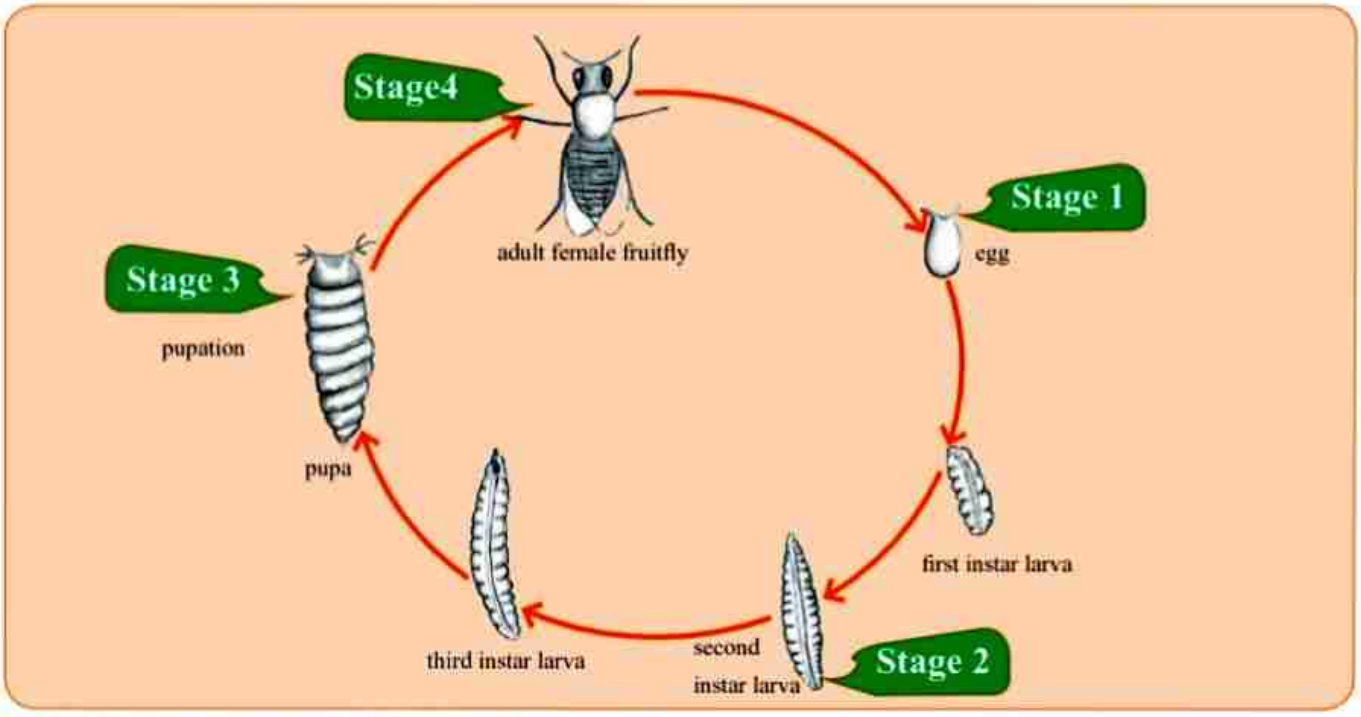


Fig. 6.1 Complete metamorphosis of a fruitfly

Incomplete metamorphosis

Incomplete metamorphosis is a type of life cycle which does not follow the four stages of egg, larva, pupa and adult stage, but follows three-stages which are egg, nymph and adult. In this type of a life cycle, after hatching from the egg, the insect does not go through significant change in body shape but goes through an increase in body size from young insect to an adult insect. Examples of pests following incomplete metamorphosis are locusts, grasshoppers, aphids, termites, scales and bugs.

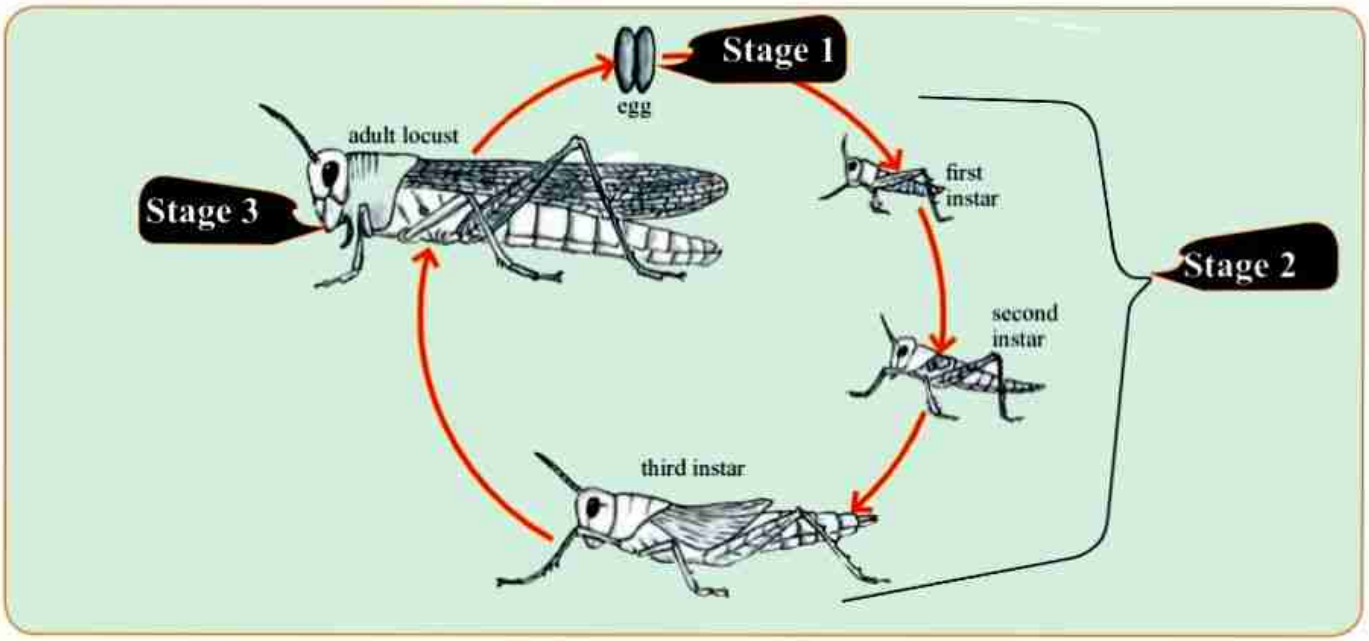


Fig. 6.2 Incomplete metamorphosis of a locust

Activity 6.1

Scouting for pests in the field or garden

1. In groups of five, visit cropped areas.
2. Identify the various pests and their developmental stages.
3. Suggest type of life cycle for identified pests.
4. For conservation reasons, you can take photographs of the various pests and correctly label the pictures on cell phones, tablets and computers. This does not result in killing of insects for specimens.
5. Upload pictures taken in the field on to computers and then create photo files for pests that undergo complete metamorphosis.
6. Correctly label each pest and save the files.
7. If you do not have the appropriate equipment for steps 4, 5 and 6, you can draw the identified pests and label your diagrams and file them in your farm diaries.

Activity 6.2

Drawing and labelling insect life cycles

1. Draw and label an insect life cycle, illustrating complete metamorphosis and incomplete metamorphosis.

Plant diseases

A plant disease is a state of the plant where there is abnormal function of plant parts and disorders in plant biochemical or physiological processes that sustain healthy plant development. Plant diseases are classified according to their causative agent.

There are diseases caused by small living organisms, also known as pathogens. These are broadly referred to as pathogenic diseases. Pathogens are tiny disease-causing organisms such as bacteria, fungi, viruses, worms, nematodes and algae. Pathogenic diseases are further classified into classes such as bacterial diseases, fungal diseases and viral diseases, amongst the most common.

Improper soil nutrient management, by farmers, can also result in nutrient deficiencies or toxicities. This results in nutritional diseases. Nutritional deficiency diseases are a result of lack of essential nutrients such as nitrogen, potassium and phosphorous.

Physiological disorders or physiological diseases are a result of factors such as poor hygienic practises, use of diseased planting materials and improper handling of the plants.

Disease transmission

Disease transmission refers to how diseases are spread from one plant to the next. There are several ways through which diseases are spread and these can be natural ways or through poor farming practices.

Methods of disease transmission

Vectors: Vectors are insect pests that carry disease-causing pathogens especially viruses from one plant to the next or from one area to another. Viral diseases, for example, are spread by sap sucking insect pests as they feed. The pathogens are carried in the vectors' saliva.

Wind: Wind can transport disease-causing pathogens from infected plants to non-infected plants. Fungal spores (structures in fungi that act as seed) can be moved from one plant to the other by wind, resulting in spread of fungal diseases.

Poor hygienic practices in the nursery: High levels of hygiene should be maintained in the nursery to avoid introduction of diseases into nursery and to minimise spread of diseases from one plant to the next. An infected nursery will result in a diseased crop in the field. Farmers should restrict entry into the nursery and put foot baths, which are small ponds with liquid disinfectants to destroy pathogens on shoe soles.

Poor cultural practices: Farmers who lack modern farming practices can carry out certain practices that promote spread of diseases. For example, farmers can carry out fruit tree pruning moving from one plant to the next using the same tool without disinfecting the tool. This results in transmission of diseases from plant to plant.

Improper management of crop remains: Diseased crop residues or remains can result in spread of diseases from previous crop to the next crop if not destroyed in good time. This is very important for tobacco farmers. Tobacco farmers should destroy tobacco crop remains by certain dates required by authorities to minimise spread of diseases.

Poor weed and pest management: Weeds and vector pests help to spread diseases and if not controlled, result in rapid spread of diseases.

Movement of agricultural products: Some fruits, leafy vegetables, grains and seed may carry diseases with them as they are distributed in the marketing system. These products may spread or introduce diseases to crops in some areas.

General symptoms of plant diseases

The most common groups or classes of plant diseases are fungal, bacterial and viral diseases. It is important for farmers to identify the general plant symptoms of the three classes of diseases for correct implementation of measures to control the diseases.

Fungal diseases

These are plant diseases that are caused by fungi, a non-photosynthesizing parasitic plant. Fungi reproduces through tiny structures called spores which act as seeds. Fungal spores are very small such that they are easily spread by wind, water or contact.

Fig. 6.3 Fungi and fungal diseased plant

Table 6.1 Fungal diseases, transmission and symptoms

Disease	Transmission	Symptoms
Fungal diseases These are diseases caused by fungi.	• Spores from infected plant is spread by wind. Spread rapidly under wet or high humidity conditions.	• Retarded plant growth • Light coloured patches and dirty white to greyish moulds are seen on upper and lower leaf surfaces, respectively.
Examples of fungal diseases		
Disease	**Transmission**	**Symptoms**
Late blight This is a fungal disease which attacks tomatoes and potatoes. 	• Spread through use of diseased plant parts as seed. • Spores could be spread through splashing rain drops and wind to healthy plant. • The spread of the disease is fast in warm and moist conditions	• Red brown colour on skin of potato tubers. • Small water soaked lesions and white moulds are seen on upper and underside leaf surfaces. • If affected, the plant quickly turns brown when dry and black when wet.

Disease	Transmission	Symptoms
Downey mildew A fungal disease which attacks beans and peas. 	• Spores from infected plant is spread by wind. • Under wet or high humidity conditions the disease is spread rapidly.	• Retarded plant growth. • Light coloured patches and dirty white to greyish moulds are seen on upper and lower leaf surfaces, respectively.
Grey leaf spot This is a fungal disease which attacks mainly maize crop. 	• Spread through diseased plant parts and seeds. • Spores are blown or spread by wind.	• Spores on infected leaves. • Some pale brown coloured leaf sports are seen on leaf veins.

Bacterial diseases

Bacterial diseases are diseases caused by microscopic single celled organisms called bacteria. Bacteria is so small that it can get into cells of other organisms. This disturbs normal function of infected cells of plants resulting in diseases.

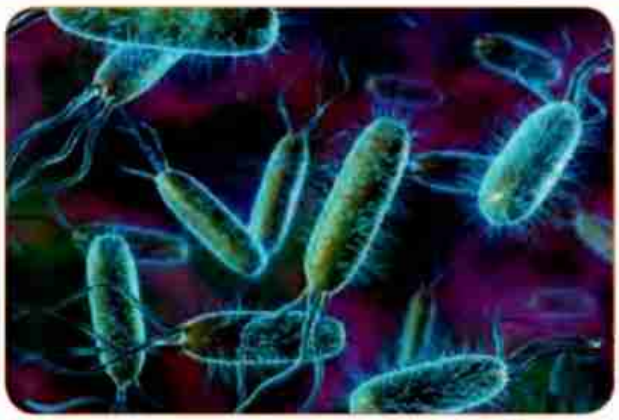
Bacteria	Bacteria diseased plant
	

Fig. 6.4 Bacteria

Table 6.2 Bacterial disease, their transmission and symptoms

Disease	Transmission	Symptoms
Bacterial diseases They are caused by bacterial infections.	• Generally transmitted through use of non-certified seed which is infected. • Contaminated irrigation water can also help spread the disease.	• Symptoms vary but in general, development of lesions, spots, changes in leaf colour may occur and plant may also wilt in cases of bacterial wilting.
Examples of plant bacterial diseases		
Bacterial blight: The disease is also known as *angular leaf spot.* 	• The disease can be spread through irrigation water, rain and wind. • It is also spread by use of infected seeds.	• Lesions develop on leaf veins, petioles and stem. • Small water soaked angular leaf spots are seen on leaves of infected plants.
Black rot: This is a bacterial disease common in brassica plants like cabbages. 	• The disease is spread through use of diseased plant parts and seeds.	• Affected plants show browning at edges of leaves. • Infected vascular tissues become black in colour.

Viral diseases

Viruses are a small unit of genetic material with mechanisms to infect other cells and change the normal function of the cells infected. Viral infections result in viral diseases. Most viral diseases have no cure.

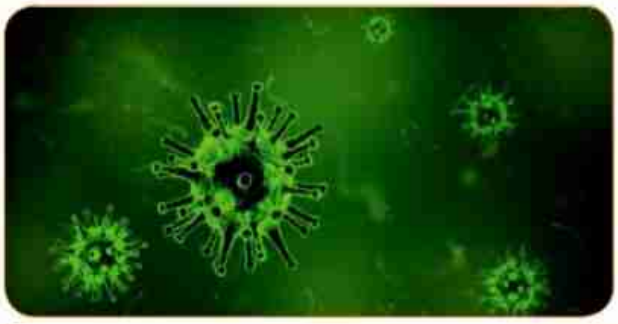
Virus	Viral diseased plant
	

Fig. 6.5 Virus

Table 6.3 Viral diseases, their transmission and symptoms

Diseases	Transmission	Symptoms
Viral disease These are caused by entry of viruses into plant cells.	Viral diseases are generally transmitted through infected tools or equipment, wind, vectors and can also be spread by infected plant remains.	• Viral diseases generally result in stunted growth of plants. • Chlorosis, leaf curling and spots are common symptoms of viral diseases.
Examples of viral diseases		
Rosette: A viral disease which usually attacks groundnuts. 	• It can be spread through use of diseased seeds. • It can also be spread through implements and wind.	• Usually there is retarded growth in infected plants. • Some leaves become curled and deformed. • The crop may turn yellowish with tiny numerous spots on the leaves.
Maize streak virus: This is a viral disease which mainly attacks cereal crops. 	• The disease is spread by vectors like leaf hoppers on maize. • Can also spread through diseased plant remains used as compost.	• Infected plants show chlorosis on leaf veins. • There is stunted growth in maize and crop may produce very small cobs or no cobs at all.

Activity 6.3

Discussion on spread of diseases

1. In groups, discuss the various ways through which crop diseases can be spread.
2. Compile a list of discussed methods of spread of diseases.
3. Discuss and share the methods from your group with the rest of the class.

Activity 6.4

Scouting for plant diseases

1. Visit the school garden, field or nearby cropped area.
2. Collect diseased plant parts.
3. Identify the diseases and describe the symptoms and signs observed.
4. Make a record of your findings in the farm diary.

Activity 6.5

Watching videos and high definition images of plant diseases

Documentary videos and high definition images can be obtained from the internet where there is internet connection.

1. Cell phones, tablets and computers connected to the internet can be used for this activity.
2. From the start menu access your computer browser by clicking on it.
3. On the dialogue box, type in or select a search engine of your choice such as google.
4. Search for free video sites.
5. On the dialogue box or where you input command, type key words of your search to easily access desired information.
6. Use search words (key) or phrases such as 'documentary videos of crop diseases' or 'images of bacterial plant diseases.'

   If you have no internet access you can make a field visit to farms in your area and observe any affected plants.

Activity 6.6

Giving advice to local community on how they can combat crop diseases

It has been observed that the local community is facing a serious diseases outbreak in their fields for the past seasons. As an agriculture student, you are tasked to visit the community and give them advice on how they can reduce this problem. Find out the common diseases causing the problem and come up with control measures.

Weeds

A weed refers to plants which grow where they are not wanted or plants that are out of place. A rapoko plant growing in a groundnut field is a weed. Weeds are plants which interfere with the growth of desired planted crops. Weeds reduce yields, lower crop value and may totally hinder crop production.

Characteristics of weeds

Weeds are identified by the following features:

- They produce plenty of seeds at a time. For example, black jack can produce over 100 000 seeds per plant.
- Most weeds disperse their seeds over long distances. For example, black jack and star burr have seeds that can hook onto passing animals or people.
- Other weeds can grow from stems which could have been broken from the main plant. Such weeds include couch grass, kikuyu, wondering jew and others in the grass family.
- They form a well-developed root system. For example, rapoko grass is very difficult to remove from the soil because of its thick root system.
- Weeds can grow and survive in different climatic conditions. For example, khaki weed, black jack and couch grass grow in all regions of Zimbabwe.
- Many weeds can grow on hard compacted land. This includes weeds such as bobbin weed and khaki weeds which can even grow on the roadside and in old fields.
- Weeds, for example, black jack, rapoko grass, wondering jew and star burr, have a very fast-growing rate compared to most field and garden crops.

Classification of weeds

Weeds can be classified according to the period they take to grow and produce seed or simply their life cycle. Some weeds can be classified further according to type of leaves into broad and narrow leaved. Grasses are narrow leaved weeds.

Classification based on morphology

This classification is based on structural features of the plants. In this classification, weeds are classified into broad leaved, grasses and sedges.

Broad leaved weeds

These are weeds which have very wide and broad shaped leaves. The leaves are net veined. Examples of broad leaved weeds include black jack, wondering jew and thorn apple. They are very easy to control using selective herbicides known as broad leaved herbicides. They are easy to control because of the large leaf surface area which facilitates the absorption of chemical herbicides. They are more susceptible to drying out once their roots are disturbed or exposed. Broad leaved weeds are also classified as dicotyledonous plants.

Fig. 6.6 Broad leaved weeds

Grasses

This is a class of weeds made of mostly grasses which have long, narrow and spiral shaped leaves. Grasses have small leaf area. This makes them resistant to chemical due to poor chemical penetration. Grasses can survive in dry conditions because of their adaptability features such as the small leaf surface area and robust root system. Examples include most grasses like finger grass, couch grass and goose grass. Most crop weeds come from this family.

Fig 6.7 Grasses

Sedges

They can be annual and perennial grass-like plants with aerial flower-bearing stems. Leaves of these weeds are mostly from the base, having modified stem with or without tubers. Examples include the umbrella sedge, yellow nutsedge, purple nutsedge and Cyperus rotundus.

Fig. 6.8 Sedges

Classification according to life cycle

This classification is based on the period taken by a plant to grow and produce seed. In this classification, plants are grouped into annuals and perennials. The annuals or perennials can either be grasses or broad leaved.

Annual weeds

These are weeds which grow, mature and produce seeds in one season. Most of these weeds are very common during the rainy season. After the crops have been harvested, most of these weeds die. They are easy to control compared to other types of weeds.

Annual grasses

These weeds are in the grass family and produce seed in one season, every season they are reproduced from seed. Examples of annual grasses include finger grass (*Digitaria spp*) and goose grass (*Eleusine indica*).

Fig. 6.9 Annual grass weeds

Annual broad leaved (dicotyledonous) weeds

Annual broad leaved weeds have broad leaves that are net veined. Examples of broad leaved annuals include black jack (*Bidens pilosa*), witch weed (*Striga asiatica*), mexican marigold (*Tagetes minuta*) and thorn apple (*Datura stramonium*).


black-jack


thorn apple


witch weed

Fig. 6.10 Annual broad leaved weeds

Perennial weeds

These are weeds which require more than one growing season to complete their lifecycle. The perennial grasses have roots or rhizomes which store food. During the dry period, they rely on stored food. Broad leaved perennials are very problematic weeds. In general, perennial weeds are a bit difficult to control than annual weeds.

Perennial grass weeds

These are weeds in the grass family that require more than one season to complete their lifecycle. Perennial grass weeds can exist for several years. Examples of perennial grasses include star grass (*Cynodon nlemfuensis*), couch grass (*Cynodon dactylon)*, rapoko grass (*Eleusine indica*), silver spike (*Imperata cylindrical*) and kikuyu grass. (*Pennisetum clandestinum*)


rapoko grass


couch grass

Fig. 6.11 Perennial grass weeds

Perennial broad leaved weeds

These are broad leaved weeds that complete their life cycle in more than one season. Examples of common broad leaved perennials include oxalis (*oxalis latifolia*) and lantana (*lantana camara*).


oxalis


lantana camara

Fig. 6.12 Perennial broad leaved weeds

Mode of spread of weeds

Weeds are spread through several ways and methods. Several agents such as water, wind, animals or birds are responsible for the spread of weeds. There are some weeds which have self-seed dispersal mechanisms such as the explosive method.

The mode of spread of weeds include:

Wind dispersal

Wind is an agent for dispersal of some weed seeds. Seeds that are feathery, papery and winged in nature are blown away and spread to distant areas by wind. Examples of such weeds include black jack and the thorn apple.

Fig. 6.13 Feathery weed seed

Water dispersal

Water helps to transport some particular type of weed seeds. Some weed seeds float in water and are thereby carried away from the mother. When deposited, they start new life away. Examples of such weeds include the jacaranda and the coconut seeds.

Fig. 6.14 Floating weed seed

Animal or bird dispersal

Some weed seeds have hooks. These get hooked to the furs of passing animals or clothes of people and then are deposited a distance from the parent plant. Examples of such weeds include black jack and star burr. Other weed seeds are succulent and when eaten, pass out undigested, away from the parent plant. Examples of such weed seeds include, guava seeds.

Fig. 6.15 Hooked black jack seeds

Self-dispersal

This method of seed dispersal is common in pod-forming weed seeds. When dry, they shrivel and explode open. This scatters the seeds away from the parent plant.

Fig. 6.16 Pod weed seed

Activity 6.7

Identifying, collecting and examining weeds

Materials: flat file, pen and glue or sticking tape

Procedure:

1. Individually walk around the school grounds and fields and identify and collect different types of weeds.
2. Paste or stick the weeds onto a flat file according to their classifications.
3. Label each pasted weed, write its English and indigenous name, possible mode of spread and at least one observable outstanding feature.

Summary

- Pests, diseases and weeds are the most common crop enemies.
- These damages affect plant growth, flowering and fruiting. The damages seriously affect the final yield if left unchecked.
- Incomplete metamorphosis is a life cycle where development of insect from hatching to adult insect does not result in complete change of shape throughout development.
- Complete metamorphosis is a life cycle where there is total change in shape as insect develops through larval stage, pupal stage and adult stage.
- Plant diseases are spread through many methods such as wind, water and poor farming practices.
- Bacteria, fungi and viruses are pathogens that cause plant diseases.
- Crop diseases are classified into bacterial, fungal and viral diseases or according to the cause of the disease.
- Different diseases show similar or different signs and symptoms. Farmers should be able to identify these plant enemies and use correct measures to control them.
- Weeds are crops that grow where they are not wanted.
- Weeds are classified into annuals, perennials, grasses, broad leaved and sedges.

Glossary

Bacterial diseases: these are plant diseases which are caused by bacteria
Chlorosis: yellowing of plants due to destruction of chlorophyll
Infection: entry of pathogens into healthy cells resulting in diseases
Morphology: this is structural form or shape of plant parts
Plant pest: it is an organism which can cause damage to a crop
Seed dispersal: this is the distribution of seeds away from the parent plant to new areas. It prevents overcrowding
Stunted growth: slow growth
Weeds: these are plants which grow where they are not wanted. For example, maize plant growing in a groundnut field is a weed

End of chapter questions

1. The following pests undergo complete metamorphosis except:
   A. moth B. butterflies C. locust D. fruit fly
2. All are fungal diseases of plants except:
   A. Late blight B. Angular leaf spot C. Downey mildew D. Grey leaf spot
3. Light and papery weeds are most likely to be spread by:
   A. Water B. Wind C. Animals D. Self
4. An example of an annual weed is:
   A. Black jack B. Kikuyu C. Couch grass D. Spear grass
5. Using examples, describe the following:
   a) Annual weeds (4)
   b) Perennial weeds (4)
6. With the aid of examples, describe three ways by which weeds can be dispersed. (9)
7. Give five characteristics of weeds. (5)
8. Briefly explain ways through which diseases are transmitted or spread. (6)
9. What are the causes of plant diseases? (10)
10. Complete the table below, by classifying the diseases and stating the common crop attacked. (6)

Disease	Type	Common crop affected
e.g. Mildew	Fungal	Beans
Blight Rosette Grey leaf spot		

11. It has been brought to your attention that your community is facing a serious problem of rapid weed spread by water. Come up with mitigatory measures to reduce the spread of weeds. (3)
12. Describe the life cycle of a named insect which undergoes incomplete metamorphosis. (5)
13. Give the general symptoms of fungal diseases. (3)
14. Suggest reasons why annual broad leaved weeds are easier to control than perennial grasses. (2)
15. List the three classes of weeds and give an example for each class. (6)

CHAPTER 7

Animal husbandry: Types of livestock and reproduction in poultry

Chapter objectives

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

- identify ruminant animals and non-ruminant animals
- distinguish characteristics between ruminants from non-ruminants
- draw the digestive system of a ruminant and a non-ruminant
- identify major parts of a digestive system of a goat and a hen and give their functions
- draw and label the reproductive system of a cock and a hen
- describe the process of egg formation
- state functions of each part of an egg
- draw and label parts of an egg

Key concepts

- Ruminants and non-ruminants
- Reproduction in poultry

Introduction

Animal husbandry is one of the branches of Agriculture, which deals with rearing of animals. Livestock animals kept on the farm can be classified into two broad classes, ruminants and non-ruminants. This classification is based on the differences of animal digestive systems. The major distinguishing anatomical difference between ruminant and non-ruminant animals is that ruminant animals have distinct four chambered stomach whereas non-ruminants have a single stomach chamber. Differences in animal digestive systems require farmers to carefully plan their animal feeding schemes and programmes to meet the nutritional requirements of their farm animals.

Poultry animals include all bird-like animals kept by farmers. Examples include broiler chickens, indigenous chicken breeds such as bushveld, turkeys, ducks and many others. Reproduction in poultry is by way of fertilised eggs that hatch into chicks. Successful reproduction in chicken requires a cock and a hen. The reproductive systems of a cock and a hen will be discussed in detail to give a better understanding of the involved processes.

Ruminants

Ruminants are animals with four stomach chambers. These animals are said to be poly-gastric (have more than one stomach chamber). Their stomach is very complex, consisting of the rumen, reticulum, omasum and abomasum. Examples of ruminant animals are cattle, goats and sheep. During grazing, the grass is stored in the rumen, waiting for further chewing. Food is softened, fermented and broken down by action of bacteria, protozoa and fungi. Bulk of the food that ruminants eat consist of grass. Ruminants benefit from cellulose in the grass because of the millions of rumen microbes which can breakdown cellulose. The microbes are found in their first three stomach chambers. Ruminant animals chew the food stored in the rumen during grazing for the second time after regurgitation (bringing back food from rumen to mouth). This process of re-chewing is called rumination, commonly referred to as chewing the cud. The digestion process is mechanical from the mouth up to the omasum (third stomach chamber). Ruminant animals do not have salivary amylase. Enzymatic digestion starts in the abomasum, which is the true stomach. In the true stomach, rumen microbes are destroyed by the hydrochloric acid produced by the walls of the true stomach.

Digestion in ruminant animals

The digestive system of a cow

A cow is an example of a ruminant animal with four stomach chambers. All other ruminants have similar digestive system with basic four distinctive chambers. Figure 7.1 shows the digestive system of a cow and Table 7.1 shows functions of parts of the digestive system of a cow.

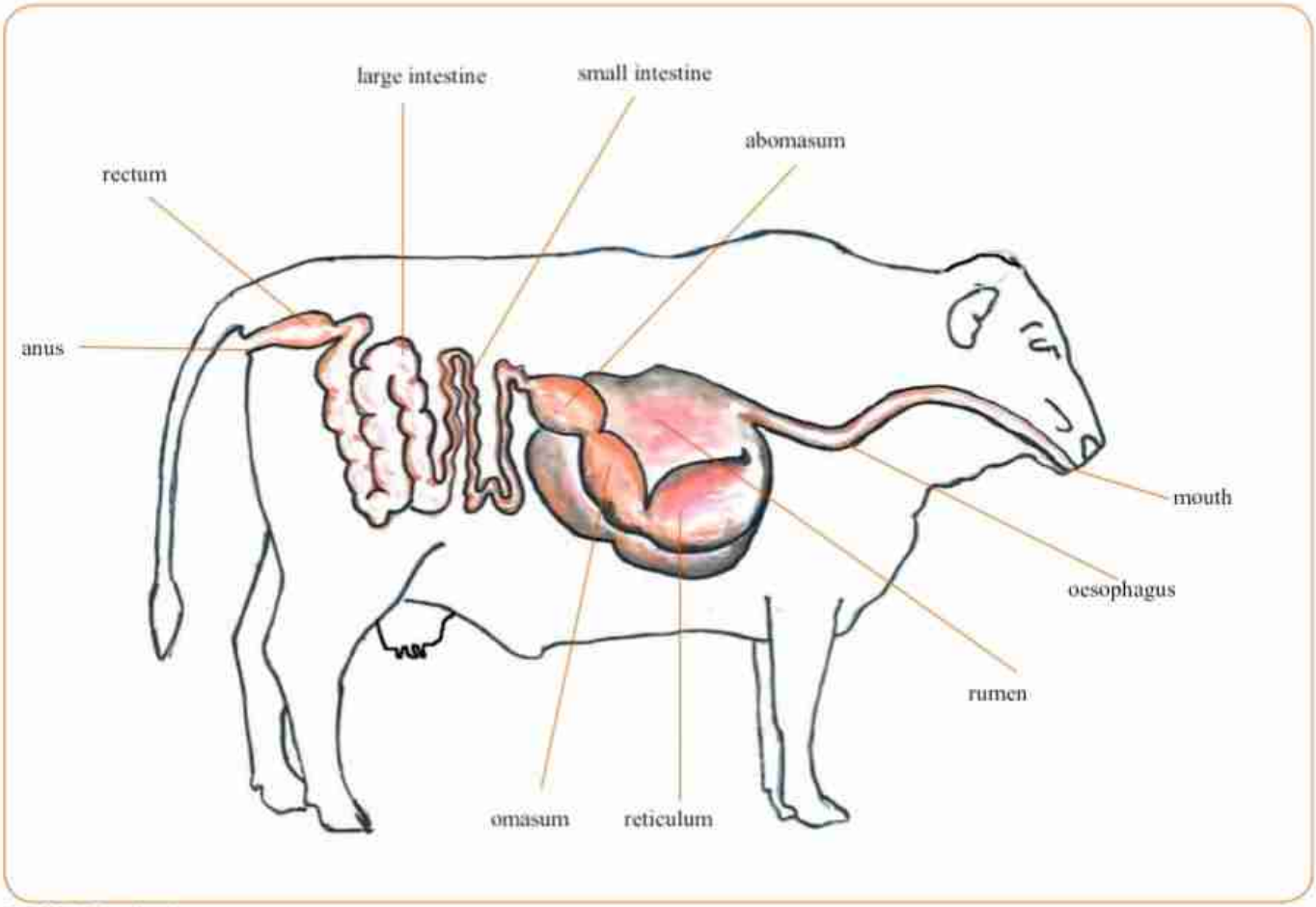


Fig 7.1 Cow's digestive system

Table 7.1 Functions of parts of the digestive system of a cow

Part	Functions
Rumen	• Storing of food during feeding. • Contains microbes which help to digest the food and breakdown cellulose. • It synthesizes vitamin B complex.
Reticulum	• Separating coarse food materials from fine ones.
Omasum	• It is for storage and grinding of food. • Omasum traps foreign materials.
Abomasum	• Thorough food digestion by the help of enzymes.
Small intestine/ ilium	• Absorbs nutrients from digested materials into the blood stream.
Large intestine/ colon	• The large intestines absorb water from digested waste before being passed out.
Caecum	• Contains bacteria that breaks down cellulose.
Rectum	• Temporarily stores dung before the dung is passed out.

Sheep and goats

Sheep and goats are other ruminant animals with typical four chambered digestive systems. Digestion and function of the parts is similar in all ruminants

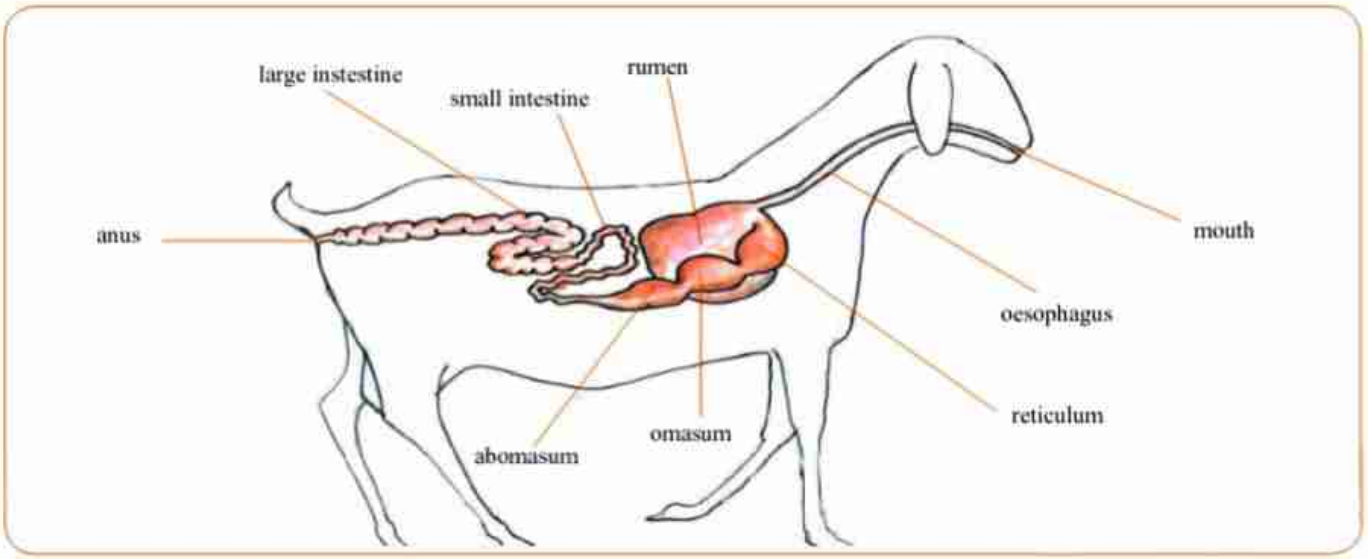


Fig. 7.2 Digestive systems of sheep and goats

Non-ruminants

Non-ruminants are animals with one stomach chamber. They have a single stomach and are termed mono-gastric. Examples of non-ruminants include pigs, poultry, donkeys, mules, horses and rabbits. Most of these animals do not benefit much on grass feed because they do not have rumen microbes which can digest cellulose. However, other non-ruminant animals like rabbits, have very big caecum which contains some micro-organisms which can further break down or digest cellulose. Because of that, non-ruminants rely mostly on straight feeds such as crushed maize and nutrient concentrate feeds. Most of the digestion in non-ruminants is dominated by mechanical digestion from the mouth to the stomach.

Digestion in non-ruminants

Hen

The digestive system or alimentary canal is a system of parts that breaks down food substances to their simplest form that can be absorbed into the blood stream and used for various body requirements. The digestive system of a hen is made of the oesophagus, crop, stomach, gizzard, small intestines, large intestines, caeca and vent. Table 7.2 shows the functions of parts of digestive system of a hen.

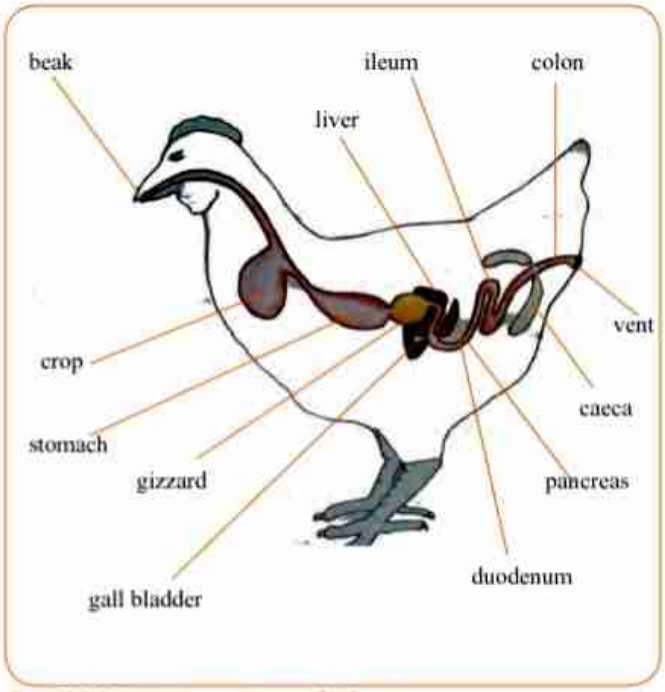


Fig. 7.3 Digestive system of a hen

Table. 7.2 Functions of parts of the digestive system of a hen

Part	Functions
Beak	• Pecking, tearing and picking the food.
Oesophagus	• It is the passage of food from the mouth into the crop.
Crop	• It is where food is temporarily kept whilst being moistened.
Stomach	• Stomach walls secrete hydrochloric acid and gastric juice. Hydrochloric acid regulates the pH while the gastric juice contains enzyme like ptylin which acts on food. • The stomach can also be called the proventriculus.
Gizzard	• In the gizzard partly digested food is ground up by the aid of small stones called grit. The grit refers to small stones found in the gizzard which grind the food into chime.
Gall bladder	• Stores bile, which is made by the liver. Bile is released in the ileum, • Bile salts correct the pH to an alkaline state, enhancing other enzymes to work properly.
Pancreas	• It produces pancreatic juice which has many enzymes to digest the food.
Caeca	• These are two closed tubes joining the ileum from opposite sides • Mammals have got only one caeca. • Caeca helps to digest cellulose in the diet.
Ileum	• Produces enzymes which help in the digestion of food materials. • The ileum has a large surface area provided by the microvilli which allows soluble food substances to be absorbed into the blood.
Colon	• The colon is also called the large intestines. • Large intestines are responsible for water absorption from digested material back into the blood stream.
Vent	• Allows faeces to pass out

Rabbit

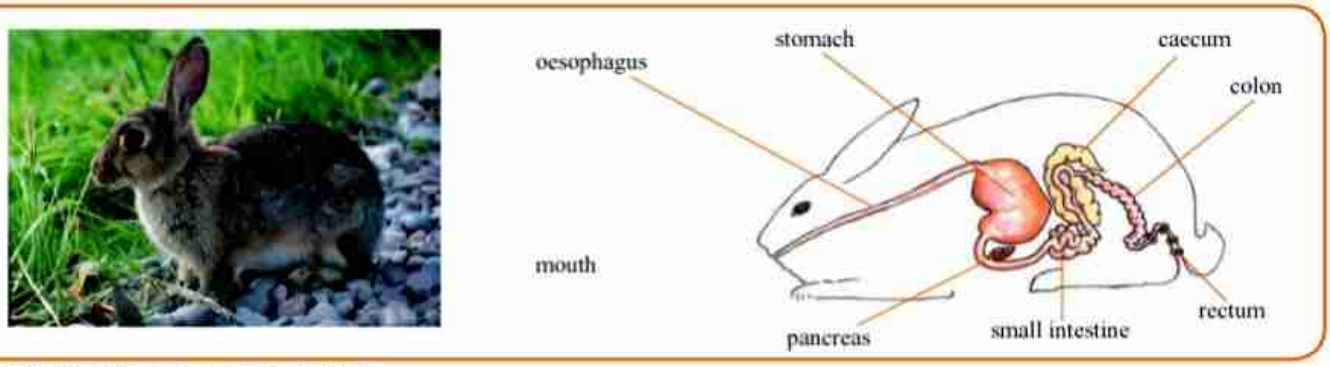


Fig. 7.4 Digestive system of a rabbit

Table. 7.3 Functions of parts of the digestive system of a rabbit

Parts	Functions
Mouth	• Food is chewed and mixed with saliva containing enzyme amylase commonly referred to as salivary amylase.
Oesophagus	• This is the passage which directs partly digested food materials into the stomach.
Stomach	• This is a sac where food is mixed with gastric juice which contains protein-digesting enzymes and hydrochloric acid.
Pancreas	• The pancreas produces pancreatic juice which contains enzymes which digest fats, starch and proteins.
Caecum	• The caecum houses special strains of bacteria which digest cellulose or fibrous food. • Rabbits and horses manage to digest grass because they have a large caecum.

Pig

A pig is another example of a non-ruminant with a single chambered digestive system. Digestion is almost similar for all non-ruminants. The parts of the digestive systems play the same roles in breakdown of food.

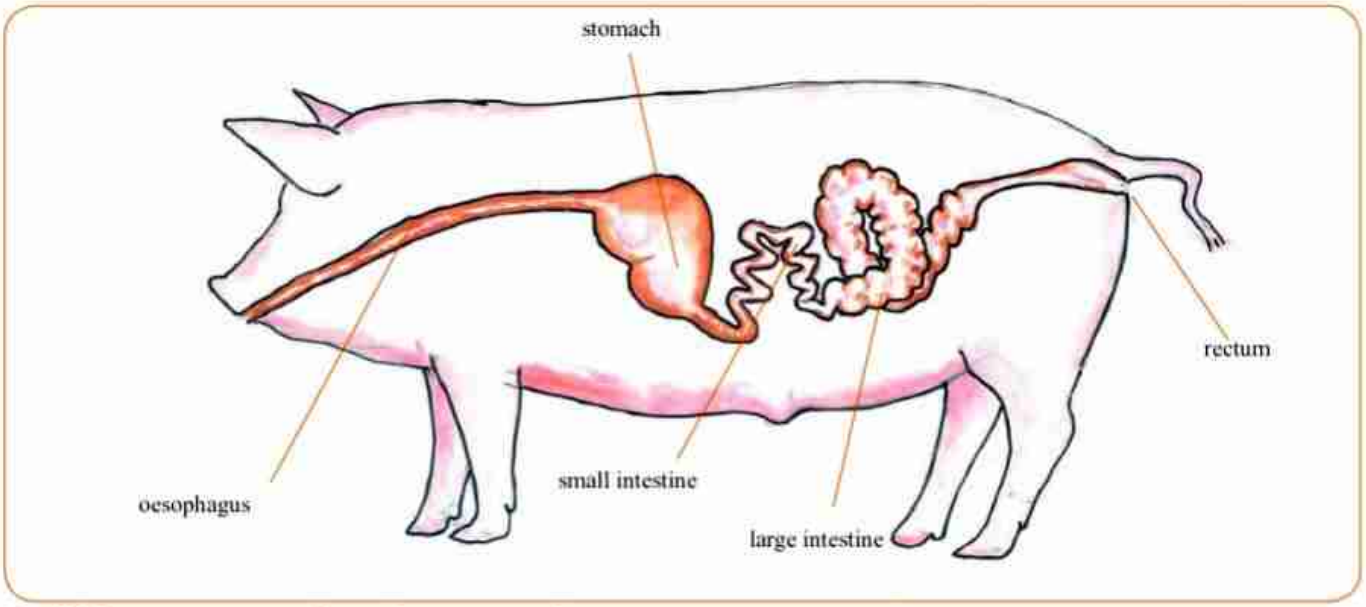


Fig. 7.5 Digestive system of a pig (non-ruminant)

Activity 7.1

Dissecting and observing internal parts of a hen

1. Slaughter a hen and cut it open without damaging or distorting the digestive parts and their arrangement.
2. Special attention should be on the digestive system as you dissect and identify major parts.
3. Carefully study the internal parts of a slaughtered hen and if possible take photographs or make drawings for filing.
4. Make short notes on appearances of the parts.

Comparison between ruminant and non-ruminant

Table 7.4 Comparison between ruminant and non-ruminant

Ruminant animals	Non-ruminant animals
1. Have four stomach chambers.	Have a single stomach chamber.
2. Chew the cud.	Do not chew the cud.
3. Contain millions of microbes found in the chambers.	Contain microbes in their caecum.
4. Do not have salivary amylase.	Have salivary amylase.
5. Can survive on non-protein containing food.	Cannot survive on non-protein containing food.
6. Regurgitate food.	Cannot regurgitate food.

Activity 7.2

Identifying ruminant and non-ruminant digestive systems

1. Search for images or diagrams of digestive systems of various farm livestock animals such as hen, rabbit, goat, pig, duck and horse.
2. Group digestive systems of ruminants and non-ruminants justifying the groupings.
3. Identify and list all the livestock animals common in your area.
4. Identify and classify them into ruminants and non-ruminants, giving facts to support your answer.

Reproduction in poultry

Poultry animals are a class or family of domesticated animals that are very important to human life. They are usually kept for meat, eggs and showy purposes. Poultry family include chicken, duck, turkey, guinea fowl, goose and pigeon. The poultry breeds kept for their eggs are called Layers, while those kept for meat are called Broilers. However, some poultry are kept for both meat and egg production. Such poultry are said to be for dual purpose. These include indigenous chicken breeds such as the Bushveld and Rhodes island red.

Poultry reproduction is by means of eggs. The eggs need to be fertilised by a cock and then need incubation, for a specific period of time according to the type of poultry animal, for them to develop into new chicks.

When rearing poultry for breeding purposes, the mating ratio is 1 cock to 12 or 15 hens. A good layer can lay a total of 12 to 20 eggs and then go broody. Hatching would be done by the brooder hen or by an electronic machine called incubator. Nowadays, people are preferring to rear indigenous chicken breeds commonly referred to as road-runners. This is because of their good lean meat which they provide, which is said to be healthier to consumers. If well kept, indigenous chicken breeds are equally good in their production rate.

Reproductive system of a hen

The reproductive system of a hen is made up of parts that are mainly responsible for egg formation.

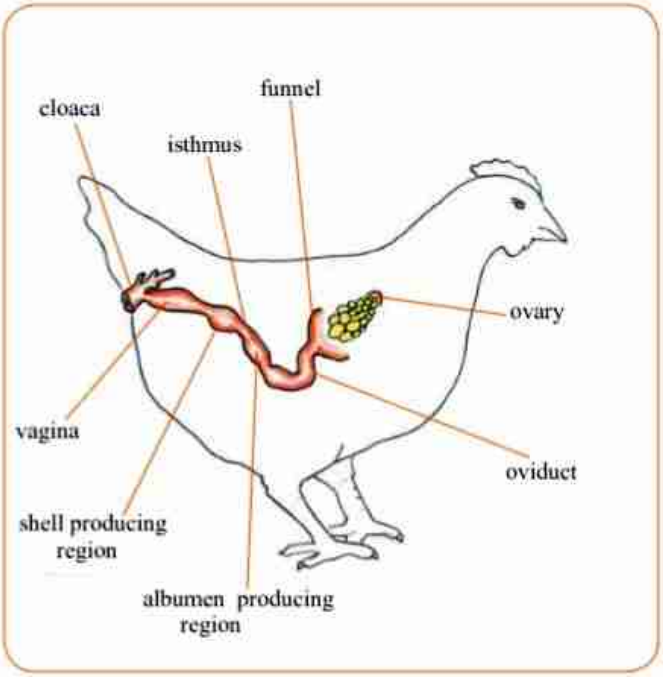


Fig. 7.6 Reproductive system of a hen

Egg formation

The egg of a bird is much bigger in size than that of mammal animals. This is because the development of the embryo in birds takes place outside the body of the female. The egg has to contain enough food for the embryo until it is hatched. A mature egg is released from the ovary past the funnel into the oviduct. There it is fertilised by a sperm. Albumen and shell are added in the Magnum and Isthmus, respectively, as the fertilised egg moves down the reproductive tract. Later the egg is laid as a fully developed egg through the cloaca of a hen.

Functions of the reproductive parts of a hen

Table 7.5 Functions of the reproductive parts of a hen

Part	Function
Ovary	• This is the organ responsible for producing the eggs or ova.
Ova/eggs	• Female reproductive sex cells which when fertilized develop to produce a zygote.
Funnel	• The funnel receives a mature egg from the ovary and leads it into the egg tube.
Oviduct	• Is the part or section where fertilisation of the egg takes place. It can also be termed the egg-tube. • A mature egg is released in the oviduct where it will meet the sperm from the cock.
Magnum	• This is the part responsible for secretion of albumen and wrapping it around ovum. • It directs ovum to the isthmus.
Isthmus	• It adds shell membrane to the yolk. • It leads the ovum to the shell gland.
Shell gland	• Makes the egg shell which is a soft shell at this stage. • Moves the egg into the vagina.
Vagina	• Is a passage where the male organ (cock penis) is inserted during mating. • It is also a passage for the wastes.
Cloaca/vent	• Is the opening responsible for letting out the egg and the wastes. • It prevents dust from entering the vagina.

The egg

The egg is the female poultry reproductive structure which begins as the ova. The ova is fertilised and various components are added such as the albumen and shell to enable the egg to develop outside the hen's body. A well developed and mature egg has a strong shell. The shell is strong and porous to allow the developing chick to breathe. This therefore implies that the eggs need to be kept in a well-ventilated place.

The egg contains two membranes which are separated at one end by the air space. One should make sure that collected eggs are kept clean by cleaning them using a clean cloth.

The structure of an egg

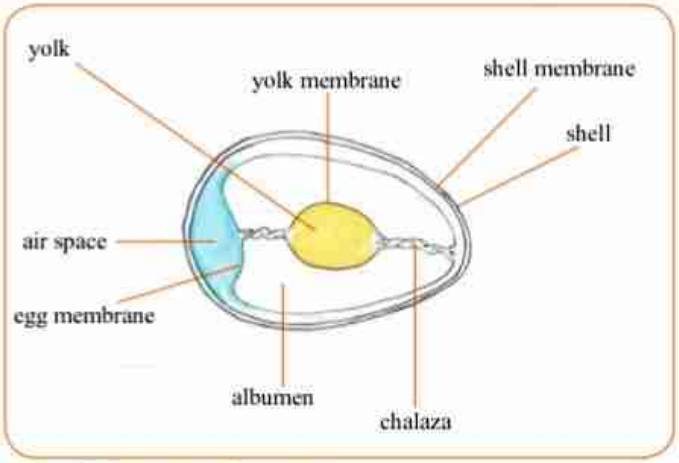


Fig. 7.7 Structure of an egg

Functions of egg parts

Table 7.6 Functions of egg parts

Parts	Function
Egg shell	• This is a hard-protective coating which is porous. It allows air movement and gives shape to the egg.
Albumen	• This is the egg part which serves both as food reserve and as a protective layer for the developing embryo. • It is also called the egg white.
Chalaza	• This is a twisted white material which balances the egg yolk.
Yolk	• The yolk develops into an embryo when fertilized.
Air space	• Contains air for the developing chick to breathe.
Outer membrane	• The outer membrane protects the egg against disease-causing organisms.

Activity 7.3

Identifying the parts of an egg from a dissected egg

1. In small groups, carefully break an egg over a saucer and study the contents.
2. Identify the membrane, chalaza, albumen and yolk.
3. Some parts of the egg are easier to identify when boiled, so boil the egg, break it open and identify the parts.

The reproductive system of a cock

Reproductive system of a cock

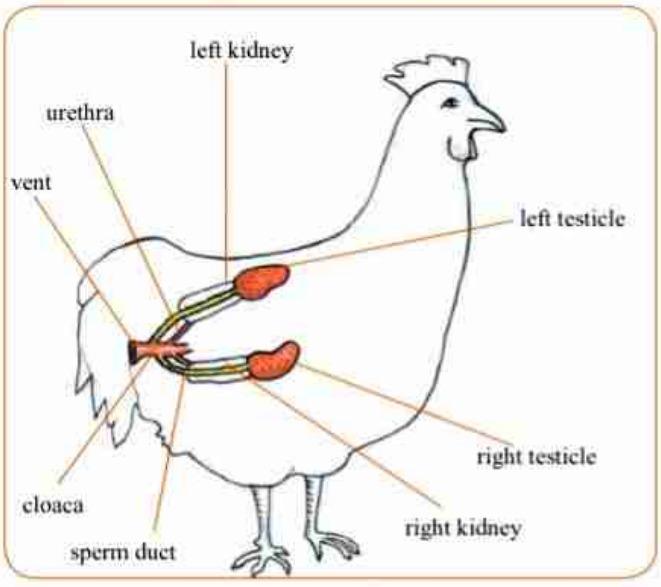


Fig. 7.8 Reproductive system of a cock

Table 7.7 Functions of reproductive parts of a cock

Part	Functions
Testicles	• These are the organs inside the body that manufacture and store sperms that are ready for mating.
Sperm duct	• This is a tube which leads sperms from the testicles to the cloaca.
Cloaca	• This is the opening through which sperms are passed out during mating. • During mating, the cloaca of the male and the female are pressed together and the sperms are transferred from the cock to the hen.

Activity 7.4

Dissecting and observing cock reproductive system

1. In groups, dissect a cock.
2. Identify the reproductive parts.
3. Draw the reproductive parts as observed.

Summary

- Ruminant animals have four stomach chambers.
- Non-ruminants have a single stomach chamber.
- Ruminant animals have specialised stomach structure which suits their diet of plant materials.
- Ruminants contain microbes found in the first three stomach chambers that assist in digestion.
- [illegible] have a stomach structure which cannot fully utilise fibrous (cellulose) food materials.
- [illegible] have a very simple stomach which is suitable for simple straight feed.
- Some non-ruminants like rabbits and horses have very large caecum which can house microbes for the [illegible]ellulose.
- Poultry animals are kept for many purposes such as egg and meat production.
- Poultry reproduction involves reproductive systems of the hen and the cock to produce fertiled eggs which develop into chicks.
- The hen produces an egg which needs to be internally fertilised by a cock for it to hatch a chick.
- In poultry, the egg develops outside the body.

Glossary

Digestion: this is the breaking down of food substances into simpler state that can be absorbed into the blood stream and be utilised by the body

Digestive system: refers to the whole gut from the mouth to the anus

Dissecting: opening of a dead body of an animal with the intention of observing the internal parts

Enzyme: this is a biological catalyst which speeds up chemical reactions

Gastric juice: it is special fluid produced by the stomach which enhances digestion

Mono-gastric: refers to an animal with a single stomach

Poly-gastric: is an animal with more than one stomach chamber, such as a goat and a cow

Regurgitation: bringing the food back into the mouth for further chewing

Brooder hen: it is the mother hen used to hatch eggs naturally

Embryo: it is the resulting mass of cells from fertilisation which develops into an individual

Fertilization: this is when a sperm and an egg fuse together to form a zygote

Incubator: an incubator is a machine which is used to hatch a large number of eggs at once

Mating ratio: it is the particular number of female chickens needed to mate a single cock

End of chapter questions

1. All are ruminant animals except:
   A. Cattle B. Rabbit C. Goats D. Sheep
2. The true stomach of a ruminant animal is:
   A. Abomasum B. Rumen C. Reticulum D. Omasum
3. Non-ruminant animals:
   A. Chew the cud
   B. Do not have salivary amylase
   C. Have four stomach chambers
   D. Do not regurgitate food
4. Mating ratio in poultry is:
   A. 3 to 21-36 B. 1 to 12-15 C. 4 to 5 D. 2 to 10

Summary

- Ruminant animals have four stomach chambers.
- Non-ruminants have a single stomach chamber.
- Ruminant animals have specialised stomach structure which suits their diet of plant materials.
- Ruminants contain microbes found in the first three stomach chambers that assist in digestion.
- Non-ruminants have a stomach structure which cannot fully utilise fibrous (cellulose) food materials.
- Non-ruminants have a very simple stomach which is suitable for simple straight feed.
- Some non-ruminants like rabbits and horses have very large caecum which can house microbes for the digestion of cellulose.
- Poultry animals are kept for many purposes such as egg and meat production.
- Poultry reproduction involves reproductive systems of the hen and the cock to produce fertiled eggs which develop into chicks.
- The hen produces an egg which needs to be internally fertilised by a cock for it to hatch a chick.
- In poultry, the egg develops outside the body.

Glossary

Digestion: this is the breaking down of food substances into simpler state that can be absorbed into the blood stream and be utilised by the body

Digestive system: refers to the whole gut from the mouth to the anus

Dissecting: opening of a dead body of an animal with the intention of observing the internal parts

Enzyme: this is a biological catalyst which speeds up chemical reactions

Gastric juice: it is special fluid produced by the stomach which enhances digestion

Mono-gastric: refers to an animal with a single stomach

Poly-gastric: is an animal with more than one stomach chamber, such as a goat and a cow

Regurgitation: bringing the food back into the mouth for further chewing

Brooder hen: it is the mother hen used to hatch eggs naturally

Embryo: it is the resulting mass of cells from fertilisation which develops into an individual

Fertilization: this is when a sperm and an egg fuse together to form a zygote

Incubator: an incubator is a machine which is used to hatch a large number of eggs at once

Mating ratio: it is the particular number of female chickens needed to mate a single cock

End of chapter questions

1. All are ruminant animals except:
   A. Cattle B. Rabbit C. Goats D. Sheep
2. The true stomach of a ruminant animal is:
   A. Abomasum B. Rumen C. Reticulum D. Omasum
3. Non-ruminant animals:
   A. Chew the cud
   B. Do not have salivary amylase
   C. Have four stomach chambers
   D. Do not regurgitate food
4. Mating ratio in poultry is:
   A. 3 to 21-36 B. 1 to 12-15 C. 4 to 5 D. 2 to 10

5. Mature eggs are produced in the:
   A. Funnel B. Oviduct C. Ovary D. Cloaca
6. State the difference between the digestive system of ruminants and non-ruminants. [12]
7. Give the correct order or sequential arrangement of the ruminant stomach chambers. [4]
8. Explain why rabbits are able to digest some fibrous feeds. [2]
9. With the aid of a diagram, describe how digestion occurs in a:
   a) Goat [8]
   b) Hen [8]
10. Explain why non-ruminants should not be fed on fibrous feeds. [3]
11. Label the parts A, B, C and D on the cock reproductive system. [4]

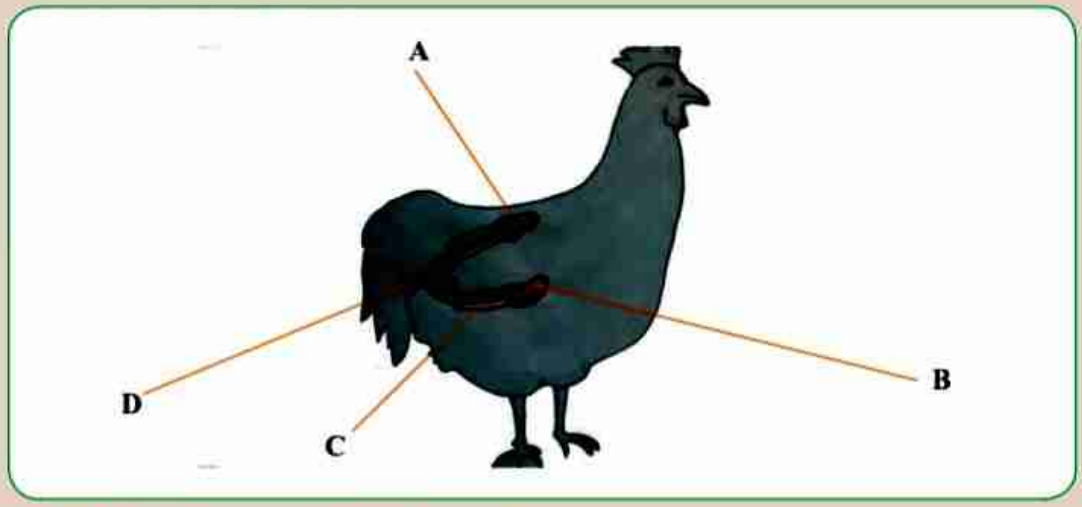


Fig. 7.8 Cock reproductive system diagram

12. Describe the functions of the parts you have labelled. [12]
13. Discuss the importance of a cock in poultry reproduction. [3]
14. Identify and label the parts on the hen's reproductive system. [8]

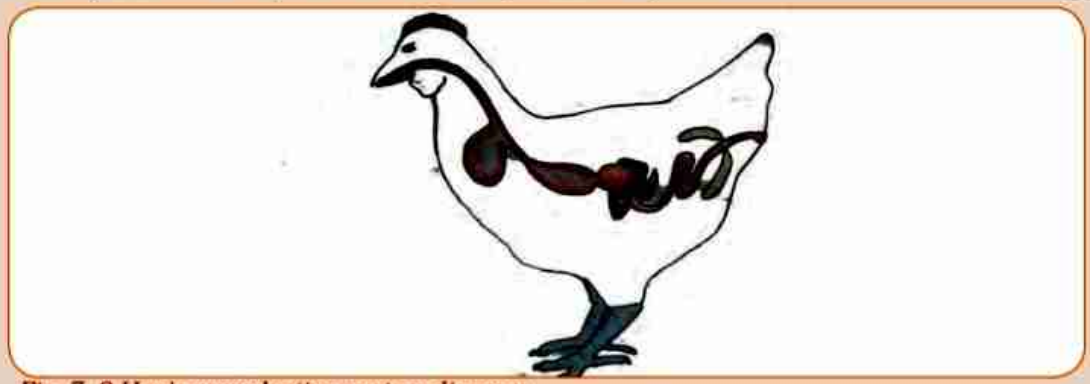


Fig. 7. 9 Hen's reproductive system diagram

15. Give the functions of the following egg parts:
   a) Membrane
   b) Yolk
   c) Chalaza
   d) Albumen
   e) Shell (5)

CHAPTER 8

Animal nutrition, health and small livestock production

Chapter objectives

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

- correctly name the six main nutrients required by farm livestock
- comprehensively explain the functions of each of the six main nutrients required by farm animals
- describe deficiency symptoms of each of the six main nutrients required by farm animals
- identify sources of each of the six main nutrients required by farm animals
- explain causes of diseases
- explain modes of livestock disease transmission
- justify the importance of hygiene
- discuss methods of disease control
- rear broilers
- select type of feeds from day old to slaughter
- assess growth rates of broiler chickens
- keep physical and financial records of farm enterprises
- demonstrate the slaughtering and dressing of broilers
- calculate dressing and killing out percentage
- identify market for broilers

Key concepts

- Livestock nutrients
- Livestock diseases and hygiene
- Broiler management
- Slaughtering, processing and marketing

Introduction

The study of the food materials required by animals, and how the animals use the food in their bodies is called animal nutrition. It is the duty of the farmer to make sure that the livestock animals get the right type of nutrients and the right quantity of food. Livestock animals need a balanced diet for them to live in good and productive health. Lack of nutrients will result in the animals failing to grow as expected of livestock, and may lead to nutritional diseases and body deformities. It is therefore important for a livestock farmer to have at least a basic knowledge of animal nutrition. Knowledge on animal nutritional requirements enables farmers to plan and implement livestock feeding programs that meet desired goals and targets.

Animal health is a term which describes the state or condition of an animal with reference to the function and appearance of its body parts, organs and body processes.

A healthy livestock animal is one whose body parts are functioning harmoniously with each other. An ill-health livestock animal is one whose body parts and processes are not functioning properly. It is important to keep animals in good health for them to perform their best, in breeding and in production of animal products such as eggs, milk and meat.

Red meats, such as beef, goat, wild life, and others are becoming unpopular for health reasons. This is because they can cause diseases such as gout. As such, white meats (of which broilers are) are gaining popularity. Broilers, being small livestock animals that do not require much space and time to raise, can fit well as good substitute for red meats.

Animal nutrition

Types of animal nutrients required by livestock

For good functioning of the body, the food that constitute the **diet** that the animal eats should contain six main nutrients. Nutrients are the simple substances the animal gets when the food it eats has been digested or broken down to their simplest soluble form by the digestive system. The nutrients should be in the right proportions, which are well balanced. Each nutrient has specific functions it performs in the animal body. An oversupply or under supply of one or more of the nutrients can cause the animal body not to function properly, resulting in sickness or death, which is not good when in business.

For the animal to be able to use the nutrients, the food should be supplied to the animal in a form that can be digested [broken down] in the animal's digestive system. Ruminant and non-ruminant livestock animals have different nutritional requirements and feeds that their bodies can utilize. Regardless of the differences in animal nutritional requirements, all livestock animals require the six main essential nutrients as listed below.

The six major livestock animal nutrients

- Carbohydrates
- Proteins
- Fats
- Oils
- Minerals
- Vitamins
- Water

The table below describes the six main animal nutrients, the nutrient sources, their functions and common symptoms of their deficiencies.

Table 8.1 Livestock nutrients

Nutrient	Nutrient sources	Functions of the nutrients	Nutrient deficiency symptoms
Carbohydrates	• Grass • Cereal grains • Molasses • Milk • Hay	Provide energy for: • Work • Reproduction • Warmth • Digestion • Chemical reactions in the body and other bodily functions. • Fat production	• Emaciation or muscle wasting • Starvation • Loss of weight • Body weakness
Proteins	• Blood meal • Fish meal • Hay and silage • Groundnut cake • Soya cake	• The proteins are used for growth • Proteins are important for maintenance of body fluid pH • They provide components for repair of body tissues • Proteins are needed for milk, egg, and wool production • Protein components are used for the formation of many internal fluid secretions of the animal such as enzymes and digestive juices	• Emaciation (muscle wasting) • Stunted or slow growth • Reduced production in meat, milk and eggs • Animal death

Nutrient	Nutrient sources	Functions of the nutrients	Nutrient deficiency symptoms
Fats and oils	• Milk • Oil seeds [sun flower, ground nuts, cotton] • Cotton seed cake • Soya been cake and meal	• They provide energy • Fats protect vital organs such as heart, kidneys from shock • Fat layer under skin keeps animals warm in cold times • Carry fat-soluble vitamins	• Night blindness • Pneumonia • Blindness in newly born calves
Vitamins			
A	• Green plants • Yellow maize	• Required for good eye sight • Important for reproduction	• Night blindness • Blindness in newly born calves
B	• Green grass • Fish meal • Cereals • Milk • Well preserved hay	• Needed for normal growth and function • Assist in utilization of carbohydrates by the body	• Loss of appetite • Nervous disorders • Paralysis of legs in poultry • Reduced growth • Anaemia
C	• Green grass • Most animals make it in their bodies • Green plants • Milk	• Chemical reactions in the body	• No deficiency
E	• Cereal grains	• For fertility	• Infertility • Skeletal and heart muscle degeneration
K	• Fish meal • Green grass • Ruminants make their own vitamin **K**	• For fertility • Essential for clotting of blood	• Injured animals take long period of time bleeding

Nutrient	Nutrient sources	Functions of the nutrients	Nutrient deficiency symptoms
Minerals: Major minerals			
Calcium	• Green plants • Milk • Mineral licks • Bone meal	• Bone formation • Teeth formation	• Rickets in young animals • Weak brittle bones in old animals • Weak egg shells • Milk fever in cows • Rickets • Chewing hard objects • Infertility
Phosphorus	• Green grazing • Bone meal • Fish meal	• Required for bone formation • Teeth formation	• Rickets • Weak brittle bones
Magnesium	• Green grazing	• This is an important element required for bone formation • It forms part of the composition of some body fluids	• Reduced growth • Reduced milk • Animals lick soil and urine patches
Sodium	• Salt licks	• Nervous system development • Important for transmission of impulses in the animal nervous system	• Anaemia • General weakness
Trace minerals			
Iron [Fe]	• Red soil • Iron injection • Cereal grains • Legume seed	• Blood formation	• Anemia and reduced growth
Manganese [Mn]	• Green feeds	• Enzyme formation	• Disorders in body metabolic pathways that are controlled by affected enzymes
Iodine [I]	• Iodized salt licks • Green plants • Fish meal	• Part of thyroxine [growth hormone]	• Anemia and reduced growth • Goitre [enlarged thyroid gland)
Cobalt [Co]	• Green feeds • Mineral licks	• Synthesis of vitamin B_{12} in the rumen	

Nutrient	Nutrient sources	Functions of the nutrients	Nutrient deficiency symptoms
Selenium [Se]	• Grazing • Injection • Mineral licks	• Sperm formation	• Infertility
Water	• Free drinking water • Water in food • Water from respiration	• Main part of the body • Fills up cells • Cools the body • Means of transport in body • Absorption of digestion products	• Sunken eyes • Dryness of mucous membrane • Reduced food intake • Dehydration and death

The above described nutrients do not move easily on their own in the digestive system of the animal. They must be carried on by some fibrous material that can be moved by peristalsis. This fibrous material is called roughage, which is not a nutrient.

The quantities and proportions of nutrients to be given to any animal will depend on type of animal and intended outcome from the animal. An animal may be fed on **maintenance ration** just to maintain its body without changing its weight or producing any product such as milk or eggs. An animal may be given extra feed above the maintenance ration to make it do some work, produce eggs, milk, or breed. This type of feed provision is called **production ration**, and should be fed to the animal according to the production required.

Activity 8.1

Discussion on importance of nutrients in the animal's body

Discuss the important functions of nutrients in the animal's body.

Activity 8.2

Experimental investigations for nutrients in feedstuffs

A. **Test for carbohydrates (starch)**

Materials: iodine solution, white tile, pipette dropper, different livestock feed samples, biuret solution, albustix, ethanol

Procedure

1. Place various animal feeds on white tiles and place a few drops of iodine solution to the feed samples.
2. Observe and take note of any colour changes on the food samples with added iodine.
3. A blue black colour is a positive test for starch indicating presence of starch or carbohydrates.

B. **Test for proteins**

Procedure

1. Add a few drops of biuret solution to food samples in solutions.
2. Observe for colour changes.
   - A blue violet colour indicates the presence of proteins.
3. Identify feed stuffs with proteins.

C. **Test for fats (emulsion test)**

Procedure

1. Prepare a solution of about 2 mililitres of food solution and place in a test tube.
2. Add ethanol and shake for about 4 minutes.
3. Take note of observations. If an emulsion is observed, fat or oil is present.

Fats can also be tested using the translucent test.

Fat translucent test

1. Rub or smear food samples onto a piece of bond paper.
2. Place a drop of water on a piece of bond paper as a control set up.
3. Fats make a translucent stain which allows light to pass through, though you cannot see through it.
4. The watermark dries up quickly.

Animal health

Animal health deals with the well-being of livestock animals. Farmers should have good stockmanship qualities that enable them to be able to better manage their livestock productively. The farmer should be able to detect signs and symptoms of sickness in good time for effective disease control. Livestock diseases are caused by several factors such as living organisms (pathogens), injuries, poisons and genetic disorders or inheritance. Knowledge of how diseases are transmitted or spread helps in better management and control of diseases on the farm. Most livestock diseases are spread through insect vectors, direct contact or indirect contact and through contaminated food. It is important for farmers to carry out practices that minimize and reduce spread of diseases.

Small livestock such as broilers kept by farmers are a very important source of lean meat that can be raised in a short space of time. Sound knowledge, care and efficient management of broilers is very critical for meaningful and profitable production.

Characteristics of healthy and unhealthy animals

The following is a comparison in appearance of a healthy and an ill-healthy (sick) animal:

Table 8.2 Characteristics of a healthy animal and an ill-health animal

Healthy animal	Ill-health animal
• Animal is alert and aware of what happens around it. • It flees from danger • Can run energetically if encouraged	• May keep head low with eyes closed • May not be aware of what goes on around it • Ill animal will not gallop around
• When it walks, its steps are regular, and walks with an easy gait	• Walks with difficulty and may fall over
• Good posture	• Poor posture
• Opens its eyes wide, and the eyes are bright • Eyes have no discharge	• The eyes are dull, and sometimes closed • Eyes have discharge at the corners
• Has good appetite shown by normal feeding or grazing	• May not feed or graze as it normally does
• Ears are cocked and move quickly, chasing flies • Ears quickly turn towards unusual sounds	• Ears hang down and move very little, may even fail to chase away flies • Ears do not turn towards unusual sounds
• Breathing is normal with no unusual sounds	• Breathing is irregular, and sometimes with unusual sounds
• Coat is smooth and shiny • The animal feels warm, soft and moist when touched	• Ill animal has rough and dull coat • Cold and dry to the touch
• Stool of correct colour and consistency, passed out at the normal frequency • The urine has a peculiar normal colour • The animal can do work • It is more productive and can produce more meat, milk, eggs and other products • High fertility levels • Efficiently makes use of feed given	• Watery stools and in some cases too dry stool • Abnormal frequency of passing out stool and urine • Weak and cannot work effectively • Less productive, produces less milk, meat, eggs, and other products • Low fertility levels • Does not utilize feed effectively and efficiently

Fig. 8.1 A healthy animal

Fig. 8.2 A sick animal

Activity 8.3

Vaccinating livestock animals

1. Using the right prescribed vaccines for the kept livestock animals and the recommended sterilized syringes, isolate the livestock animals to be vaccinated.
2. Read through the instruction leaflet and establish the right dosage. Dosage can be determined using body weight as a guide.
3. Resource persons and the facilitator will demonstrate the correct way of injecting the vaccine or medicine.
4. Using a fresh sterilized syringe for each animal, inject the vaccine or medicine to the livestock animals selected.

Causes of ill-health to farm livestock animals

Table 8.3 Causes of ill-health to farm livestock animals

Heredity	• Sometimes undesirable characteristics passed from parents to off-spring can cause cells of the body to malfunction and degenerate. • Besides strict selection of breeding animals, and heavy culling of affected animals, there is very little one can do.
Nutritional imbalances	• Too little amounts of food may lead to malnutrition, and death from starvation. • Oversupply of food may lead to diarrhoea and constipation, and sometimes obesity. • A poorly balanced diet may lead to a number of deficiency diseases such as rickets, night blindness, osteomalacia, piglet anaemia in pigs, among others. • Food containing a specific toxic substance may be harmful to animals. • Drinking water or eating food contaminated with pathogens may cause diseases to the animals. • Nutritional diseases can be controlled by ensuring animals are provided with uncontaminated balanced diet and clean water. Supplementing deficient nutrients also helps.
Poison	• These are substances which disrupt the normal functioning of the processes inside the animal body. The poisons may cause cell degeneration and animal death. • Animals may pick the substances in some poisonous plants they eat such as *Lantana camara* which is a poisonous plant to most farm livestock animals. Wilted or droughted sorghum is also poisonous when eaten by livestock. • Poison may also be accidentally eaten as chemical formulations from poorly disposed chemicals and chemical containers. • Snake poisons that result from snake bites can also be a source of poison to livestock. *Poisoning is controlled by making sure the animals do not get access to the poisons. When poisoned, giving recommended antidote to the animal may help.*

Injury	• Can be in the form of bruises, cuts, lameness, twisted muscles or joints. Sometimes injury is serious and difficult to correct by treatment such as in the case of broken limbs, or broken ribs. • Injury may also pre-dispose animals to subsequent ill-health by exposing tissues to pathogens. *To control and reduce injuries, the farmer should ensure animal pens or grazing lands are not in a state that may cause injury to the animals. Animals must be kept calm, and not excited into galloping unnecessarily. Animals of different ages should not be mixed to avoid bullying which may result in injury. However, when injury occurs, the animal should be attended to by a veterinary officer.*
Living organisms	• Microbiological organisms: these are very small organisms that cannot be seen by the naked eye. Examples are bacteria, virus and protozoa (pathogens). • These disease-causing organisms can be picked by animals in unhygienic conditions. • They can also be passed on from animal to animal by direct contact, vectors, or through contaminated food, water and air. • Fungi: this can be spread by means of spores. • Worms: these actually live in the animal's body. Examples are flukes, tapeworms, and roundworms. *Diseases caused by living organisms can be controlled by a number of measures, chief among them being maintenance of high hygienic standards. High standards of hygiene will minimize multiplication of pathogens (disease causing organisms).* *Control of disease vectors such as tsetse flies through environmentally friendly methods helps to reduce spread of diseases such as nagana in cattle.* *Regular dosing of animals with medicines that help to eliminate internal parasites such as tape worms will assist to keep animals healthy.*

Activity 8.4

Survey on local and common causes of diseases in livestock

1. Find out from your local community and your school livestock unit the common diseases that affect livestock.
2. Establish the common causes of the diseases.
3. Write down a report of your findings and make a sound conclusion.

Methods of transmission of pathogenic diseases

Direct contact of animals

Animals can pass on the disease-causing organism to one another. This occurs when infected animals rub against or get in contact with other un-infected animals. This method of transmission is more common in contagious diseases. Contagious diseases are diseases that are spread through animal body contact or body fluids.

Indirect contact

Affected animals may cough or sneeze into the air discharging the disease-causing organisms into the air. Other animals will breathe in the contaminated air and get infected. Transmission of diseases through indirect contact is often more pronounced in infectious diseases.

Consumption of contaminated food or water

Infected animals can pass the disease-causing organisms through shared food and water. Saliva from infected animals may drop into shared food or water where it will be picked by healthy animals, resulting in diseases.

Via vectors

Blood sucking insects can suck blood from infected animals. As these insects move on and suck blood from animal to animal, they pass on the disease-causing organisms. Most disease-causing organisms can

safely survive in the saliva. Such insects, which transmit disease-causing organisms in their saliva from animal to animal through their feeding, are called vectors. A good example is the tsetse fly which transmits trypanosoma. Trypanosoma causes nagana or sleeping sickness in animals.

Activity 8.5

Investigating solutions to control and prevent livestock diseases

1. Find out from various sources ways and technologies that can be used to control and prevent diseases in livestock.
2. Your search may include use of internet, veterinary department resource persons, text books and experimental investigations.

Prevention and control of pathogenic diseases

Prevention of diseases is always better than cure and less expensive. The prevention of diseases can be achieved by providing a healthy environment for the animals.

Methods of preventing pathogenic diseases

Providing good housing structures

Good housing structures are well ventilated, have enough space and have good lighting, are easy to clean and disinfect.

Pathogens are less likely to thrive in such clean environment, limiting the chances for occurrence of diseases.

Separation of young from old animals

Old animals may be careers of some disease without themselves getting ill. They can, however, pass on the infection to young animals whose immunity will still be weak. It is therefore important to separate old and young animals.

Nutrition

Well-nourished animals are better able to resist diseases. Livestock animals should be provided with the right amounts of feed and supply of nutrients.

Isolation or quarantining

This is keeping of diseased animals away from healthy ones to prevent contact between infected and healthy animals, thus preventing spread of diseases.

Hygiene or sanitation

This is by far the most important element in controlling pathogenic diseases of animals. Clean sanitation aims at keeping disease-causing organisms in the environment of the animal at minimum possible levels. This can be achieved by:

1. Properly designed housing structures, which should:
   - be well ventilated with no draughts and without accumulation of moisture on walls and ceilings.
   - have smooth inside walls with corners rounded to facilitate effective cleaning and disinfection.
2. Using feeding and drinking utensils that are easy to clean and disinfect.
3. Proper removal and disposal of manure and other waste as these contain disease-causing agents.
4. Keeping waste pits or heaps covered to prevent breeding of flies.
5. Use of proper and clean bedding and frequent replacement of bedding.
6. Thorough cleaning of houses, followed by disinfection between batches.
7. Coating walls with white-wash containing a reliable disinfectant.
8. Proper disposal of infected litter and carcasses, by burying or burning.
9. Personal hygiene, making sure the workforce does not carry disease-causing agents to the animals on their clothes or bodies. This can be achieved by use of foot baths, bathing with detergents then putting on clean clothes before handling animals.

Activity 8.6

Discussion on the importance of hygiene in livestock units

Discuss the importance of maintaining good hygienic standards with livestock animals.

Activity 8.7

Investigation on methods of preventing diseases

1. Investigate and find out the various methods that can be used to prevent spread of diseases.
2. Internet, textbooks, documentary videos or veterinary departments can be visited to obtain information that is current and reliable.

Broiler production

Broilers are chickens specially kept for the production of quality meat at a tender age. They have been specially bred from crosses to produce hybrids of high performance with desirable characteristics such as high disease resistance.

The following are some of the advantages of keeping broilers:

- Broilers have high feed conversion ratios which give high growth rates, and therefore have quick returns.
- They produce high quality white meat. White meat reduces the risk of diseases such as gout.
- Many broilers can be accommodated on a small piece of land.
- Broilers can make maximum utilization of commercially manufactured feeds.

Broiler breeds

Gone are the days when broilers used to be pure breeds. Today hybrids have become the order of the day. These hybrids are products of crossing different breeds to come up with broiler breeds with good and desirable characteristics. Examples of breeds of broilers on the market today are the Cobb 500, Ross and Indian river. New breeds will always come up to meet the demands of the times.

Fig 8.3 Broiler breeds

Breeding programs have led to production of early maturing varieties. It used to take 12 to 13 weeks in the 1970s and 7 to 8 weeks in the 1980s and 1990s for broilers to reach market weight. It now takes 5 to 6 weeks for most of today's broiler breeds to reach market weight. Early maturity is achieved through an improvement in broiler breeds which respond well to improved feeds.

Feeding of broilers

In the rearing of broilers, the cost of feeds account for considerable proportion of the total cost of broiler production. This can be as high as 60 to 70 percent. This means feeds must be managed properly, giving the right type of feeds in the right quantities to the right age of birds.

Today the feeding regimes for broilers is tailor-made by the breeders in conjunction with the livestock feed manufacturers. However, in general, the feeding of broilers evolved into a three-phase feeding regime.

The first phase (phase 1)

Broiler chicks are fed with broiler starter, a high protein feed of about 21% protein composition. The broiler starter feed is fed to the chicks for the first two weeks.

The second phase (phase 2)

Broilers are fed with broiler grower mash or pellets, which is still relatively a high protein feed of about 19% protein composition. The broiler grower feed is fed from the third to the fourth week.

The third phase (phase 3)

In the third and final phase, from the fifth week to the time of slaughter, broilers are fed with broiler finisher. This feed has reduced protein, and is high in carbohydrate. This is to trim and produce birds with a good even cover of fat.

The feeds can be in the form of mashes or crumbs or pellets. Pellets and crumbs are economical as they reduce wastage during feeding. It is important to note that individual breeders supplying day old broiler chicks will recommend specific feeds specially formulated to suit their breed of broiler.

The rearing and management of broilers

Housing

Broilers are kept intensively in deep litter houses.

The ideal house for keeping broilers should have:

- Brick or concrete walls which should be plastered on the inside. The walls should have large openings

for good ventilation to carry away bad odours and maintain ideal temperatures.

- Good roof height for the workers' comfort.
- Solid floors to facilitate thorough cleaning and disinfection.
- Floors covered with litter 10 to 15cm deep to keep floors dry.
- Water proof roof to protect birds from rain and roof leaks. Asbestos is best. Grass thatching is also cheaper and good if properly done.

Fig. 8.4 Broilers in deep litter housing system

A deep litter house of 15m^2 should accommodate 100 mature birds.

An ideal deep litter house should look like the one shown in Figure 8.5 below.

Fig. 8.5 An ideal deep litter house

A deep litter house should accommodate brooders. Brooders are structures used to keep young broilers warm during brooding period of about two weeks from day one.

The following are brooders that can be used to house and care for young broilers in the deep litter house:

1. Hay box brooder

This consists of a run and a compartment for night enclosure. The night enclosure has a circular adjustable guard. The guard is adjustable to cater for the need for more space as the chicks grow. Hay (litter) is placed on the floors and around the guard to retain warmth produced by the chicks.

Fig. 8.6 A hay box brooder

2. Infra-red lamp brooder

This consists of an infra-red lamp and adjustable circular guard as shown in Figure 8.7 below.

Fig. 8.7 Infra-red lamp brooder with adjustable circular guard

The guard restricts chicks' movement and is adjusted as the chicks grow and need more space. The infra-red lamp provides warmth to the chicks. The warmth of the brooder can be adjusted by raising the lamp (reducing the temperature) or lowering the lamp (increasing the temperature).

The behavior of the chicks will indicate whether the temperature is good, too high, or too low for the chicks as shown in the diagrams below.

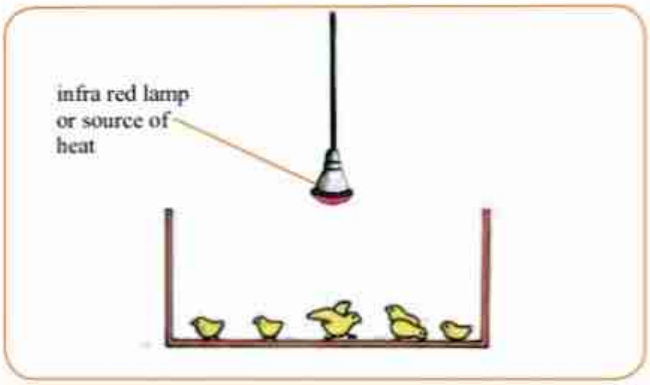


Fig. 8.8 Brooder temperature just good

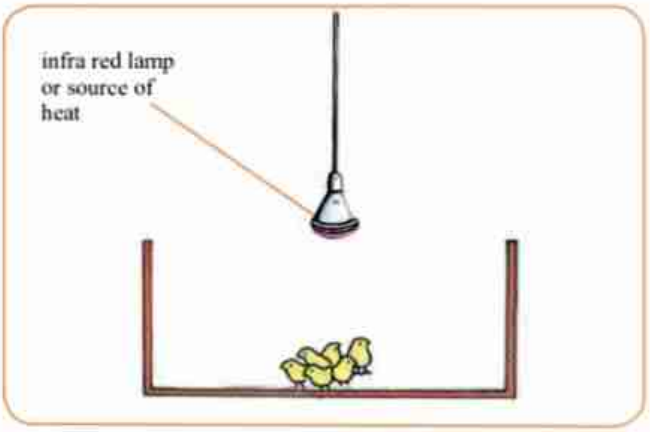


Fig. 8.9 Brooder temperature too low

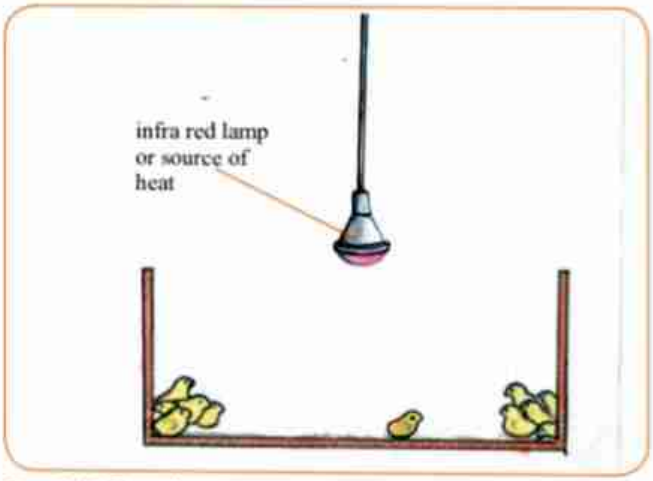


Fig. 8.10 Brooder temperature too hot

When there is draught in the brooder, the chicks will huddle together away from the incoming draught. Draught is when air movement is not even. A current of air blows in one direction and the air current can be uncomfortably hot or cold.

When in discomfort, the chicks chirp-and-chirp incessantly.

Where temperature can be controlled, the following temperature ranges, in Table 8.4, can be used as a guide.

Table 8.4 Temperature ranges for chicks from day-old to six weeks.

Age of chicks in weeks	Temperature range
0 - 1 weeks	33 - 30°c
1 - 2weeks	30 - 27°c
2 - 3weeks	27 - 24°c
3 - 4weeks	24 - 21°c
4 - 5weeks	21 - 19°c
5 - 6weeks	19°c

In the brooder, 100 chicks will require two feed trays for sufficient feeding space. From day ten onwards, 120 birds will require two tubular feeders. Water will be supplied sufficiently to 60 birds by one 12 litre water fountain.

Weighing of broilers

The broilers should be weighed regularly, most preferably weekly, to monitor growth. A few randomly picked birds can be weighed together and the average weight for each bird calculated. The average weekly weights can be recorded in a table, or a growth curve can be plotted on graph.

Fig. 8.11 An example of records of broiler weekly weight

If well taken care of, the birds will be expected to gain weight as shown in the table below.

Table 8.5 Expected broiler weight gains

Age in weeks	Expected weight in grammes
1	170
2	490
3	590
4	1470
5	2050
6	2640

This is a more generalized guide. More specific figures of expected growth can be obtained from breeders of the broilers being reared.

Record keeping for broilers

It is very important for farmers to keep physical and financial records for broiler enterprise. Physical records show number of assets, number of broilers in stock, amounts of feeds, medicines administered, broiler mass and many other records of daily activities.

Financial records are records of flow of cash throughout the production cycle. Examples of financial records include profit and loss account, records of purchases, sales records and any other record reflecting monetary value.

Below are examples of broiler records:

Financial record

Table 8.6 shows an example of a financial record showing money flowing in and out of a broiler enterprise.

Table: 8.6 Daily record of costs and sales for broiler enterprise

Date	Record/description	Sales/ income	Costs/ Expenditure
03/06/17	Purchased 50kg broiler starter mash		$35.00
18/06/17	Purchased 100kg broiler grower mash		$70.00
30/06/17	Purchased Clone 30 poultry vaccine		$10.00
12/07/17	Sold 19 broilers to Sophia kitchen	$114.00	
14/07/17	Sold 71 broilers to Chagaka high school	$426.00	
TOTAL		$540.00	$115.00

Physical farm record

Daily records of farm activities are important for tracing of sources of errors and efficient adjustments in management (see Table 8.7).

Table 8.7 Record of routine activities in broiler management

Date	Broiler number in stock	Age in weeks	Feed used	Average mass	Medicines administered	Deaths/mortality and cause
07/06/17	100	1	Broiler starter			
12/06/17	100	2		350g	Clone 30	
13/06/17	98					2 deaths, stampede
19/07/17				1.1kg		

Preparation for the arrival of day old chicks

- Clean housing thoroughly and disinfect at least 10 days before the arrival of the day-old chicks.
- Lay brooders in place before the chicks arrive.
- Pre-warm the brooder house a day before the arrival of the chicks.

Care on arrival of chicks

- Collect chicks in the morning before they are stressed.
- Check temperatures in the housing and correct accordingly.
- On arrival, physically check and count chicks as they are placed into the brooder.
- Give chicks water with a stress mix for about 30 minutes before feed is added.

Daily routines

Daily livestock management practices carried out by the farmer ensure that the farm livestock's welfare is well catered for. Success of carried out daily routines should be driven by passion and good stockmanship qualities. You should, therefore:

- Always attend to younger stock before older stock.
- Always walk calmly among the birds and check for abnormalities.
- Clean waterers or drinkers and fill with fresh clean water before putting feed.
- Shake feeders or top up feed without overfilling them. Just enough feed for the day should be availed.
- Cover wet patches with fresh dry litter to keep the birds warm and dry.

Periodically fork up the bedding for aeration and drying.

Activity 8.8

Preparation for arrival of day old chicks

With the help of your facilitator, prepare for the arrival of a batch of chickens as follows:

1. Clean out the old bedding and waste from the chicken house and safely dispose of the dung material.
2. Thoroughly clean the house with water.
3. Apply a disinfectant in the house.

Diseases that affect broilers

Table 8.8 Characteristics of diseases that affect broilers and their prevention

Disease	Cause	Signs/Symptoms	Treatment	Prevention
Coccidiosis	Protozoa Coccidia	• Ruffled feathers • Blood stained droppings • Drooping of wings • Dullness, depression and drowsiness • Chickens drink lots of water • Lack of appetite • High mortality	• Drugs such as sulphurmezathine 16%, amprol soluble in drinking water	• Coccidiostats such as Epsom salts • Sulphur drugs • Proper poultry housing management and hygiene
Fowl typhoid (F.T.)	Bacteria spread by infected water and feed	• Fever • Green-yellowish diarrhoea • Loss of appetite • Development of combs and wattles pale yellow and shrunken • Incessant chirping • Mortality of birds	• For fowl typhoid use furasol and furazoline for treatment	• Vaccination • Killing diseased birds • Good poultry house management • Buy chicks from reliable suppliers • Isolation of affected birds
Newcastle Disease (N.D.)	A notifiable disease caused by a virus	• Drooping of wings • Reduced appetite • Watery yellowish-white feaces • mucus discharge from mouth and nostrils • comb and wattles may turn bluish • birds may turn heads backwards • convulsions and paralysis	• No treatment	• Implementing a vaccinating program • Strict hygiene • Killing of affected birds • Isolating poultry unit from visitors' animals and wild birds
Fowl pox	Virus passed on by infected birds' or picked from infected feed, water and housing unit	• High body temperature • Difficulty in breathing • Nostrils and eyes will have a discharge • Yellowish blisters on combs, wattles and around beak. These later develop into brownish crusts • Difficult breathing • Loss of appetite	No treatment	• Vaccination of young stock • Strict hygiene • Isolating affected birds to prevent spreading • Control mosquitoes

Disease	Cause	Signs/Symptoms	Treatment	Prevention
Epidemic Tremor (very infectious, attacks the brain)	Virus	• Affects birds up to six weeks old • Leg/wing/neck weakness or paralysis • Trembling of the head	• No treatment	• Slaughter all stock and leave housing without birds for at least a month
Pneumonia	Cold or sudden change in temperature	• Chicks crowd together to warm themselves • Chicks have difficulty breathing followed by death	• No treatment	• Keep chicks warm

Poultry housing management

A lot of trouble with diseases in broiler rearing can be avoided by good poultry house management, and a strict vaccination programme.

Poultry housing management involves such aspects of management that reduces chances of diseases to occur.

The following are ways through which diseases can be minimized.

- The broiler housing unit should be stocked at the correct rates to avoid overcrowding.
- Strict hygiene should be practiced by keeping housing in a dry condition. This can be achieved by ensuring that the watering troughs do not spill water. Dry conditions can also be achieved by adding dry bedding to cover wet areas, or by removing the wet bedding completely.
- Store feeds properly and use the feeds within a reasonably short time.
- Keep surrounding area clean and dry.
- Keeping the disease-causing organisms out. This can be achieved by fencing the poultry unit off to prevent unauthorized access by people, or predators. The predators and humans may pass on some pathogens that cause diseases to broilers.

Pathogens can also be kept out by constructing foot baths at the entry points to the poultry unit and between units. Workers and their clothing should also be disinfected before entering housing units.

- Houses and equipment should be cleaned thoroughly and disinfected, and rested after each batch has been disposed of.
- Cleaning watering troughs and putting clean water frequently.

NB: It is important to educate workers of the importance of hygiene.

- Vaccination: vaccination is introducing into the animal body, a modified form of the disease-causing organism. The modified organism will cause a mild form of the disease. The mild disease will cause the animal's body to produce antibodies that fight the disease. The antibodies will live in the animal giving it immunity. Later, when the actual disease-causing organism [not modified] attacks the vaccinated animal it will be quickly identified and destroyed by the antibodies.

Vaccination programmes and methods of vaccination for broilers can be obtained from the suppliers of day old chicks. However, the following is a generalized programme of vaccination.

Table 8.9 General vaccination programme for broilers

Age	Disease	Vaccine	Method
10 days old	Newcastle disease	Clone 30	In drinking water
18 days old	Newcastle disease	Clone 30 [booster]	In drinking water
28 days old	Fowl pox disease	Fowl pox vaccine	Pierce skin

After vaccination, chickens may react and become ill. To minimize chances of them reacting negatively the farmer should observe the following;

- Conditions in the house such as temperatures and ventilation should be good.
- Chickens should be feeding normally.
- Chickens should be in good health.
- The instructions from the manufacturer of the vaccine and supplier of the chickens should be followed correctly.

NB: Besides good poultry house management and a good vaccination programme, diseases can be kept at bay by ordering chicks from reliable breeders and start with a clean batch.

Activity 8.9

Brooding and rearing of broilers

1. Disinfect and clean the broiler housing unit.
2. Set up brooders heat source, feeders and drinkers.
3. Provide close monitoring and attention to the chicks during the first two weeks. Follow temperature guide chart to provide necessary conditions to minimize mortality (death).
4. Prepare feeding program and dates for change of feeding phases.
5. Check the broiler feeds and water regularly every day.
6. Make records for all activities including vaccinations, change of bedding and mortality.
7. Weigh about 10 randomly selected sample broilers weekly and plot growth curves of average growth.
8. Compile financial records of purchased feeds, equipment and medicines.

Broiler chick parasites

A parasite is an organism living in or on another organism taking its food. The parasite will harm the other organism in the process. Parasites can be divided into external and internal parasites.

External parasites

These parasites live on the outer surface of the host animal. The following are examples of external parasites and the damage they cause to broilers.

Table 8.10 Common external parasites of broilers [and other poultry]

Parasite	Signs and symptoms	Treatment	Prevention/control
Tampan/fowl tick [sucks blood] 	• Anaemia • Irritation • Weakness	• Dust beds and the houses with carbaryl 5% or benzene hexachloride • Remove and burn all litter	• House should be plastered with solid concrete floor. • Cracks developing on walls and floors should be filled • Remove bark from wooden poles used in or on the house
Red mite [feeds on skin] 	• Scratching • Restlessness especially at night • Loss of weight and general weakness • Anaemia • Mortality can be high in young birds	• Spray house with malathion or cabaryl • Remove and burn litter and replace with new litter	• Ensure no cracks for mites to hide
Lice [biting and blood sucking] 	• Scratching • Loss of weight • Heavy infections can cause anaemia	• Dust beds with malathion 5% • Spray birds with dylox or paraffin	• Thorough cleaning and disinfection of houses between batches • Start with clean stock

Parasite	Signs and symptoms	Treatment	Prevention/control
Fleas [biting and blood sucking] 	• Reddish brown dots on eyelids, wattles and combs • Reduced growth • The fleas [brownish insects] can be seen on the combs, wattles, and around the eyes	• Dust chickens with malathion 5% • Spray with dylox or paraffin	• Thorough cleaning and disinfection of houses between batches
Scaly leg mite [burrows under the scales on the legs and feet]. 	• Scratching • Ruffled scales on the legs and feet	• Dip the feet and legs in benzene hexachloride	• Cull affected birds if they do not respond to treatment

Internal parasites

Internal parasites live inside the animal and feed from the animal or from food in the digestive system of the animal. This reduces productivity of the broilers.

The following table shows some internal parasites of broilers.

Table 8.11 Common internal parasites of broilers

Parasite	Signs and symptoms	Treatment	Prevention/control
Tapeworm [segmented, flat, whitish yellow worm found in intestines] 	• Blood stained droppings • Poor appetite • General weakness • May have a leg paralysis • Death may occur	Dose birds with any of the following: • lintex • butymorate • hexachlorophine	• Poultry house hygiene • Droppings with the eggs of the worms should be properly disposed of • Intermediate hosts of tapeworms should not be allowed near the broilers
Gape worm [Red in colour, found in the wind pipe] 	• Sneezing • Coughing • Difficulty in breathing through open beaks • Constant shaking of head • Drooping of wings • Ruffled feathers • Chickens half-close eyes	Dose birds with any of the following: • lintex • butymorate • hexachlorophine	• Poultry house hygiene
Roundworms [ascaris] - Many types are found in the digestive system 	• Reduced appetite • Reduced growth • Blood stained diarrhea • Drooping of wings • Ruffled feathers • General weakness • Sometimes death	• Dose birds with piperazine citrate or thiabendazole	• Thorough cleaning and disinfection of house between batches • Keeping poultry house dry

The rule of thumb is *when in doubt, consult*. It is one of the functions of the Veterinary Services Department to help farmers with animal health problems.

Activity 8.10

Cleaning and disinfecting broiler housing

Materials: Hard broom, detergent soap, Aldrin or available disinfectant, sprayer.

1. Thoroughly clean the floors and walls by scrubbing with detergents.
2. Spray the floors, interior and outside walls.
3. Lock the rooms and allow to dry.

Slaughtering of broilers (killing and dressing)

Broilers can be slaughtered as early as five to six weeks once desired weight has been reached. The period to slaughter is fast becoming shorter and shorter due to improved breeds in conjunction with improved feed formulations.

At the end of rearing broilers, the birds should end up on the market or on the kitchen table for home consumption. For home consumption, the birds should be slaughtered and dressed. For the market, the birds may be disposed of live, or they may be slaughtered and dressed.

Slaughtering and dressing for the market has the following advantages:

- Whole batches may be slaughtered at once and set fowl houses free. This allows enough time for cleaning and resting houses before the arrival of new batches.
- The birds can be sold on a per-weight basis. That is, price will be pegged on a $/kg basis, so a farmer will not lose much if broilers over stay on the farm a little longer gaining weight.
- Chickens can be kept refrigerated when they have grown uneconomically than to keep the birds alive. This reduces feed costs.
- Giblets and feathers can be sold separately to bring additional income.
- Workers will be gainfully engaged, adding value to the product.
- If batches are large, blood can be collected and processed into blood meal for livestock feeding.

The slaughtering procedure

The following include points to note and steps to follow when slaughtering broilers:

- Make sure birds are in a health state before they are slaughtered.
- The birds should have stayed the recommended time before slaughter after administration of drugs to ensure that consumers will not take in residual drugs in the meat.
- The birds should have reached an economical slaughter live weight.
- Withdraw food 12 to 18 hours before the intended slaughter time. This saves food and minimizes spoilage by gut contents during dressing.
- The birds should not be excited before slaughtering. The farmer must walk calmly and catch the birds, ideally, with a hook as shown in Figure 8.12

Fig. 8.12 Catching a bird with a hook

It is important to work out the average live weight of the birds before slaughtering them.

The killing of the birds

The killing of broilers should be done in a humane manner that should not cause pain to birds. This can be achieved by first knocking the sense out of the bird before cutting the throat. This is called stunning and can be achieved by any of the methods given below.

Broiler stunning methods

a) **Dislocating the neck**

Fig. 8.13 Dislocating the neck of a broiler

b) **Administering or giving a knock on the back of the head of the bird using a heavy object**

Fig 8.14 Giving a hard blow to the back of the head of a broiler

c) **Electric shocking**

The two methods of stunning described above are easily applicable when the birds are few. If the birds are many, a lot of time and labour will be saved by using electricity to stun the birds before cutting the throats.

Fig. 8.15 Electric shocking

Cutting broiler throats and bleeding

When the birds have been stunned, the throats are then cut with the heads hanging down. The broiler birds are placed in slaughtering cones for the neck cutting process and bleeding. The cones can be used as shown in Figure 8.16.

Fig. 8.16 Cutting throats of birds using slaughtering cones

Cutting is done to open blood vessels (jugular vein). This allows draining of blood from the bird. Bleeding should be allowed to take place for one to two minutes.

Blood not drained out of the bird will:

- taint the meat giving it the taste of blood
- make the meat easily go bad
- give the carcass a purplish discolouration

Scalding (removal of feathers)

After bleeding, the birds are immersed into hot water 50-54^{0}C for about one minute. Over keeping the bird in hot water softens the flesh and make it come out with the feathers during plucking.

Hang the bird by the legs over a clean table. Start by plucking the most difficult feathers such as tail and wing feathers, then the rest of the body. After plucking, pin feathers and some hairs can still be seen on the carcass. The pin feathers can be removed using a blunt knife, and the hairs by quickly passing the carcass over a flame of fire.

Cut the head off. Also cut the legs where the sheens join the thighs.

Removing the internal organs

- Lay the chicken on a clean table and make sure hands are clean.
- Open the skin on the back of the neck. Cut the neck bone out.
- Loosen the internal organs through the hole created by removing the neck.
- Make a hole by cutting the skin across the abdomen in front of the vent. The hole must be large enough to allow removal of the internal organs. Pull out the internal organs that include the crop, the intestines, lungs, heart, gizzard, and liver. The crop and intestines should be separated from the other organs, called giblets. The giblets should be washed and packed separately.
- The carcass should be cleaned thoroughly.
- The neck skin should be folded back to cover the hole left by the removal of the neck.
- Fold back the wings to press on the neck skin. The hocks should be pushed through the whole across the abdomen and come out through the vent as shown in Figure 8.17.

Fig. 8.17 Hocks tucked into the abdomen and out through the vent

- The carcass should be given a final wash and then packed before freezing.

The average cold dressed weight of the carcass should be calculated. This weight and the average live weight calculated before killing the birds will be used to calculate the killing out percentage.

This is done by dividing the average cold dressed weight by average live weight and multiplied by 100.

Example

Average live weight = 2.0 kg

Average cold dressed weight = 1.5 kg

Then average killing out percent will be 1.5kg /2kg x 100 = 75%

Activity 8.11

Video watching

Commercial broiler slaughtering, dressing and processing of chicken meat products

1. Search for ideal documentary videos on the internet websites.
2. Alternatively, where commercial broiler producers are close to the school, visit such areas.

Slaughtering and dressing of broilers: Summary

The following are steps in the slaughtering and dressing of broilers

- Select broilers for slaughtering and withdraw feed 12 hours before planned slaughtering time
- Supply the broiler birds with plenty of water
- Weigh each bird and record the broiler weight as mass **A**
- Stun the birds by twisting the neck or hitting the back of the broiler head with a heavy object
- Cut the jugular vein and allow blood to drain out by hanging the bird upside down
- Deep the carcass in hot water of about 50 degrees for a short while
- Pluck or remove the feathers until carcass is clean
- Make an opening on the neck to loosen the digestive system
- Cut open the across the stomach area to remove intestines, gizzard, crop and the liver
- Cut off the feet and wash the carcass
- Weigh the carcass and record the mass as mass **B** for each bird
- Calculate the killing out percentage
- Package the dressed chicken as for the market

Marketing of broilers

Producers look for markets for their products and they try to meet the demands of the identified markets. Broilers can be marketed live or cold dressed depending on the market. Broiler meat can also be processed into chicken sausages and patties.

Meat processing industries are a good market for broilers. Marketing of live broilers has the advantages of reducing slaughtering labour and costs. A good product that is well branded and packaged is easier to market and sell. Potential customers can be made aware of broiler sales through pamphlets, bulk messages and physically visiting the potential customers with sample products. A farmer needs good communication skills to convince potential buyers.

Processed and chicken meat products ready for the market

Fig. 8.18 Processed and chicken meat products

Potential markets include;

- Large retail supermarkets
- Butcheries
- Restaurants
- Boarding schools
- Food vendors
- Individual house holds
- Meat processing industry
- Children full-day care centers

Activity 8.12

Market survey

Carry out a survey to establish facts that can be used to determine a place to market broilers.

Guidelines

1. Write down introductory words to your questions. People to be interviewed should understand the purpose of your survey.
2. Establish target areas and target people for interview such as shopkeepers, butchery personnel and households.
3. Prepare a set of questions that can be used to obtain required information on broilers. The set of questions should establish facts on:
   - Household broiler consumption frequency
   - Available farmers selling broilers
   - Market prices for broilers
   - Statistics of broiler supplies and daily sales figures
4. Group your responses into classes with similar responses.
5. Write down what can be concluded from responses with the highest frequency.
6. Explain, with the gathered facts where you would market your broilers.

Summary

- Successful livestock production requires and involves knowledge on animal nutrition, animal health and animal production principles.
- It is the role of the farmer to supply farm livestock with the right quality, quantity and proportions of essential nutrients.
- The six major nutrients required by livestock animals include carbohydrates, proteins, fats or oils, minerals, vitamins and water.
- Food nutrients are obtained from various sources such as grass, milk, blood meal, hay, silage, soya cake, cereal grains, cotton seed cake and yellow maize.
- Farmers should be able to identify healthy and sick animals through observations.
- Diseases are caused by factors like heredity, nutritional deficiencies, poisons and injury.
- Methods through which diseases spread include vector insects, direct and indirect contact.
- Strict hygienic practices, isolation and quarantine of sick animals are methods that can be used to prevent spread of diseases.
- Broilers are chicken with white soft meat bred especially for meat. Broilers mature in a short space of time.
- Breeds of broilers available in Zimbabwe are Cobb 500, Ross, and Indian river.
- Broilers are fed in three phases, with each phase dominated by a particular feed type appropriate for the age.
- Brooding period is from day 1 to 2 or 3 weeks.
- Broiler housing should be cleaned, disinfected and left unoccupied for at least a week before new stock arrives. This helps to prevent diseases from old broiler stock passing to the new arrivals.
- Poultry housing should provide basic animal requirements and the farmer should keep the animal housing in a perfect state for production of healthy productive animals.
- Livestock animals should be vaccinated to protect animals from specific animal diseases.
- Parasites are organisms that survive on or inside other animals, benefiting from the food eaten by the host animal.
- Broiler parasites cause discomforts and loss of weight.
- Broilers to be slaughtered are withdrawn from feed for at least 12 hours before slaughtering time.
- Slaughtering process involve stunning, cutting the blood veins, plucking, removal of internal organs and dressing of the carcass.
- Broilers are marketed as live birds, dressed or processed to retail shops, food outlets, butcheries and many other markets.

Glossary

Anaemia	:	a condition of blood shortage
Body deformities	:	abnormal body shape
Diet	:	totality of what animals eat.
Hybrid	:	a breed resulting from cross breeding interrelated species
Maintenance ration	:	it is the amount of feed given daily to an animal to maintain it in its condition without any weight gain or loss
Production ration	:	this is the amount of feed above the maintenance ration given to animals to produce meat, milk, eggs and other desired animal production goals
Vector	:	insects that carry pathogens that cause diseases from one animal to the next

End of chapter questions

1. Carbohydrates provide
   A. proteins B. energy C. salts D. sugars
2. Lack of some essential nutrients results in:
   A. biological disease B. nutritional diseases
   C. physical injuries D. poisoning
3. Which of the following is a method of disease transmission?
   A. bacteria B. fungi C. virus D. vector
4. Which of the following shows the correct order of feeds given to broilers from day one to maturity?
   A. Broiler grower, broiler finisher, broiler starter
   B. Broiler starter, broiler grower, broiler finisher
   C. Broiler finisher, broiler starter, broiler grower
   D. Layers mash, growers mash, broiler finisher
5. What is the importance of weighing broilers regularly?
   A. to know the price B. to assess growth
   C. to control diseases D. to prevent spread of diseases
6. a) Name the six main nutrients required for the normal functioning of the body of an animal. [6]
   b) Name one source of each of the nutrients you have named in **6a** above. [3]
   c) For each of the nutrients you named in **1a** above, describe the functions. [6]
7. Clearly outline the difference between maintenance and production ration. [4]
8. Use a table to compare a health and an ill-health animal. [6]
9. Name and explain any three causes of livestock ill-health. [6]
10. Describe any three methods of preventing diseases in livestock. [6]
11. Clearly outline the procedure for slaughtering broilers up to dressing the carcass for the market. [6]
12. List any three internal parasites and three external parasites clearly differentiating the sets. [6]
13. What are the signs and symptoms of protein deficiency in livestock? [4]
14. Discuss the importance of practicing high hygienic standards in livestock production. [4]
15. Calculate the killing out percentage for a broiler with a live weight of 2.8kg and a carcass mass of 2 kg. Show your working. [3]

CHAPTER 9 Farm structures and machinery

Chapter objectives

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

- carry out adjustments on animal drawn implements
- identify materials and tools used in fencing
- discuss advantages and disadvantages of different fencing materials
- discuss factors to consider when siting a farm road
- list equipment needed when siting farm roads
- describe characteristics of well sited farm roads
- differentiate breast band from collar harnesses
- identify and label the parts of breast band and collar harnesses
- describe materials used for making harnesses
- harness specific animals

Key concepts

- Adjustments of animal drawn implements
- Fencing materials and tools
- Siting of farm roads
- Harnesses

Introduction

A farm without structures and machinery is like a school without buildings and teachers. Just as such, the school will not function properly. The same can be said for a farm lacking structures and machinery. Animal drawn implements are the most commonly and widely used farm equipment. Farm machinery reduces labour, shortens period taken to do some production operations and improves operational efficiency. The farm implements require basic understanding by the farmer to operate the machinery properly and efficiently. Fence or erect structures on the farm made for marking boundaries, keeping animals away from cropping fields and for security reasons are important structures on the farm. They allow mixed farming to be practiced on a single farm. Various materials can be used as fencing materials. These range from wood to metal. Farm fences can be erected using several tools. The farmer should know the various tools and be able to use them correctly, where appropriate.

Farms should have safe and all weather accessible farm roads that link areas of operations. The farm roads need proper siting using the right equipment. A poorly sited road will result in high maintenance costs and difficulties in movement.

Animal drawn implements are connected to draught animals through special attachments called harnesses. Harnesses are materials designed for particular types of animals according to their muscle distribution, used to link draught animals to farm equipment. It is important for farmers to identify ideal materials that can be used for harnessing equipment. The farmer should be able to know the right type of harness for a particular animal. Using the wrong harnesses on a particular animal may result in injury of the animal.

Animal drawn farm implements

Farm implements are pieces of equipment generally used outdoors in the fields especially to help with work on the farm. Implements are different from tools in that tools have got a simple design and have to be held to be used to do a particular job, such tools include a hammer, hoe, rake and many others. Implements on the other hand have a more complex design. Examples of farm implements are ploughs, cultivators, planters, harrows and ridgers. There should be a source of power for the farm implements to be used or drawn. The source of power is determined by the size of the implement and it can either be animal or tractor drawn.

Implements whose source of power is animals are called 'animal-drawn implements'. Those implements drawn by the tractor are called 'tractor-drawn implements'. This chapter is focusing mainly on animal-drawn implements. The common animals used to draw or pull implements are oxen, donkeys, horses, mules and of late, the buffalo has joined the lot. The animal drawn implements need to be adjusted to achieve desired ploughing depth and plough width.

Mouldboard plough

A mouldboard plough is the most common and widely used animal drawn implement for land preparation.

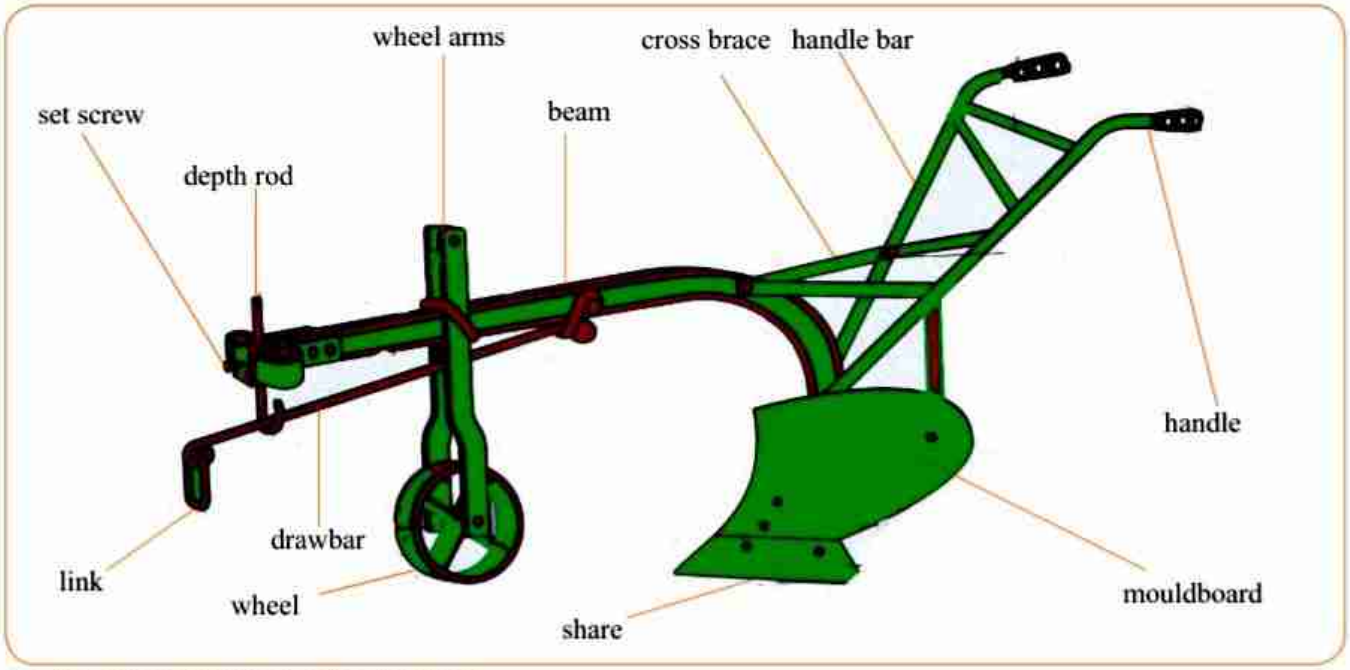


Fig. 9.1 Animal-drawn mouldboard plough

An animal-drawn plough is used for primary tillage. It digs and turns the soil over. This operation has the following benefits:

- It buries trash. The burying of trash facilitates decomposition. It also controls pests and diseases.
- Controls weeds and reduces competition with the crop.
- Loosens the soil which results in improvement of air penetration, water infiltration and drainage, and root penetration.
- Creation of a good seedbed for germinating seeds.

For the plough to function properly or perform the ploughing operation as desired, there are two basic designs of hitch assemblies that the farmer should be able to adjust correctly. The plough has to be adjusted properly in the following respects:

Depth of cut

The plough can be adjusted for the depth of cut, which is how deep it digs into the soil. This is achieved by moving the depth control rod up or down.

For the plough to cut deeper into the soil: The clamping screw is first undone, the depth control rod raised to the required level, then the clamping screw is tightened again.

For a shallower cut: For the plough to cut or dig shallower, the depth rod is lowered. The clamping screw is first undone, the depth lowered to the required level, then the clamping screw tightened.

The depth adjustment is done with the steadying wheel removed. When the desired depth is achieved, the steadying wheel is replaced at such a height that it just touches the ground surface.

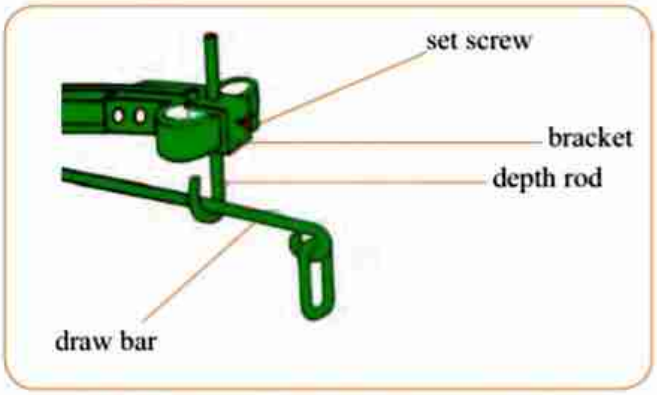


Fig. 9.2 Hitch assembly showing depth control rod

The track chain can also be used to control or adjust the depth of cut. Lengthening the track chain will make the plough cut deeper.

In place of the hitch assembly with a depth control rod, a clevis like the one shown in Figure 9.3 below can be found on some modern ploughs.

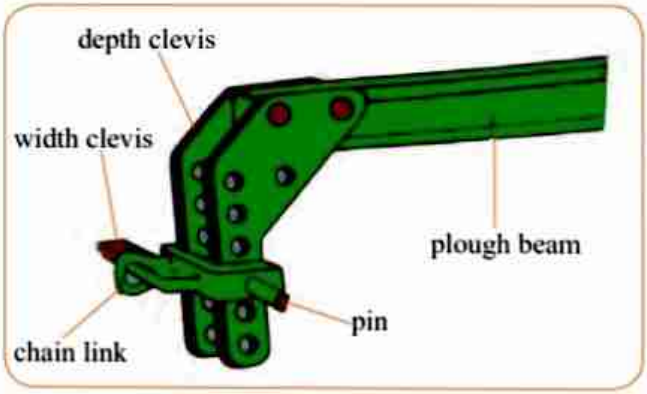


Fig. 9.3 Hitch assembly with a clevis in place of a depth rod

Width of cut

The width of the slice of soil the plough will cut during ploughing can be adjusted using the depth control rod on the hitch assembly.

Wider cut: For the plough to make a wider cut, the depth is moved to the furrow side.

Narrower cut: For the plough to make a narrower cut, the depth rod is moved to land side. Ploughs with draw bars and depth control rods are fast being replaced by ploughs with clevis like the one shown in Figure 9.3. To adjust for depth of cut, the concept remains the same. For a deeper cut, the chain hook is hooked to the top holes of the shackle. For shallower cut, the chain hook is hooked at the bottom holes.

Activity 9.1

Identifying and adjusting parts of a mouldboard plough

1. With the help of the facilitator, go to the tool room and identify the parts of an animal-drawn mouldboard plough, if it is available, or alternatively, visit where you can access a mouldboard plough.
2. Disassemble, and reassemble the components of the animal-drawn mouldboard plough.
3. Adjust the width and depth of cut of an animal-drawn mouldboard plough in operation. If you have no mouldboard plough or draught animals, your teacher can negotiate and make arrangements with people in your community.

Animal-drawn cultivator

This implement is used to mechanically control weeds in row crops, loosen soil between rows of crops, and for making planting furrows for some crops. Figure 9.4 shows the animal-drawn cultivator and its parts.

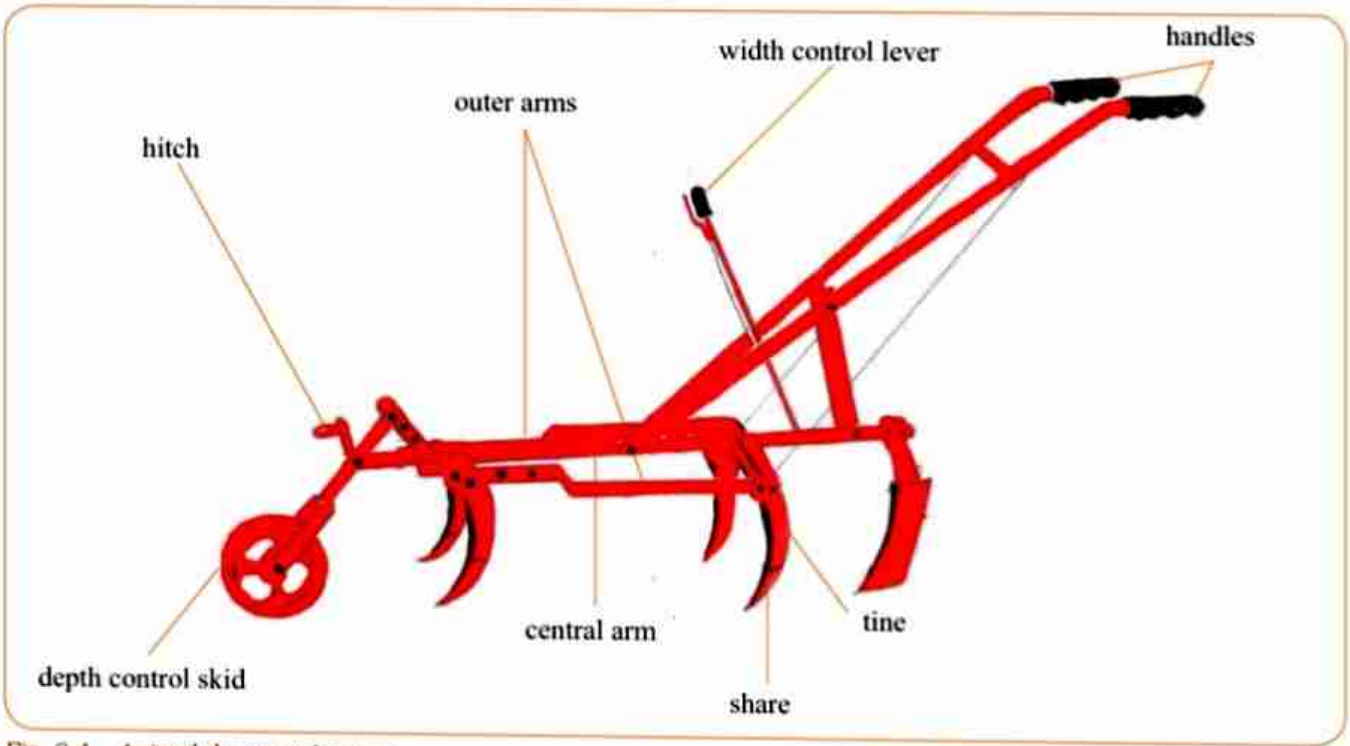


Fig. 9.4 Animal drawn cultivator

The adjustments done to the animal drawn cultivator are as follows:

Depth of cut

This is adjusted by lowering or raising the steadying wheel. The steadying wheel is raised or lowered by inclining the wheel arms or setting them in an upright position as shown in the diagram below.

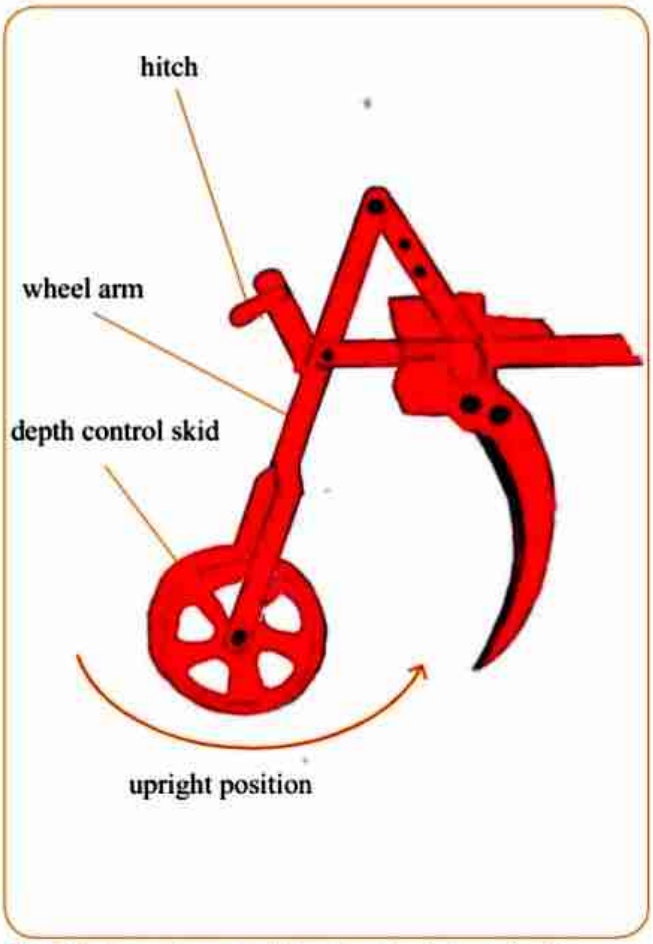


Fig. 9.5 Lowering or raising the steadying wheel

Raising the wheel makes the animal-drawn cultivator dig deeper. Another way of adjusting the depth of cut is by shortening the track chain for a shallower cut or lengthening the track chain for a deeper cut.

Adjustment of depth of cut is necessary to accommodate seeds of different sizes as they require different sowing depths.

Width of cut

The width of cut is adjusted by operating a lever which pushes out (spreads) the two outermost frames which hold the tines (wider cut) or draws them closer together towards the central frame. This makes it possible for the animal-drawn cultivator to be operated between crop rows of different inter-row spacing.

Activity 9.2

Identifying and adjusting parts of a cultivator

1. With your facilitator, go to the storeroom, or arrange a tour to a place where a cultivator can be found in the community and identify the parts of an animal-drawn cultivator.
2. Disassemble and reassemble the parts of the animal-drawn cultivator.
3. Adjust the width and depth of cut of the animal-drawn cultivator in operation.

Animal-drawn planter

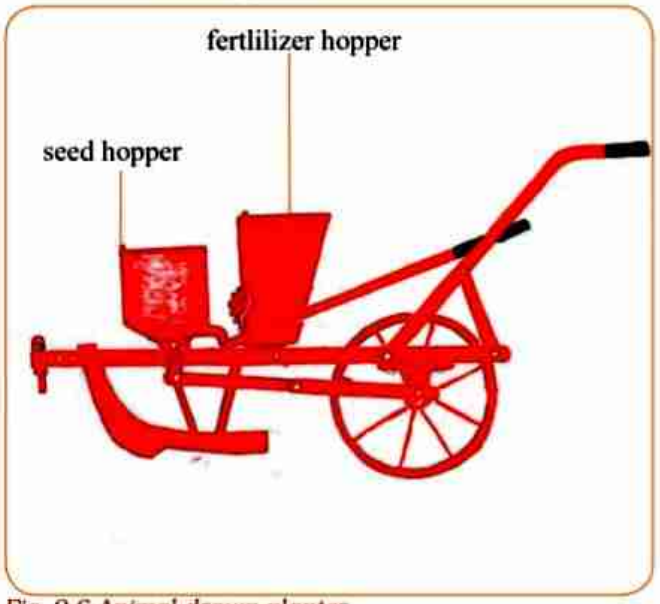


Fig. 9.6 Animal-drawn planter

This animal-drawn implement is used to plant seeds and apply fertilizer at the same time. It therefore reduces the number of operations. It saves on time and labour. It is also very accurate on the seed spacing and fertilizer rate as compared to manual application by human beings.

Depth adjustment

Adjusting the length of the track will influence the depth of planting;

- lengthening the track chain increases the depth of sowing,
- shortening the track chain will reduce the depth of sowing.

Width adjustment

This is mainly determined by the yoke with the correct beam length to give the required row spacing.

Activity 9.3

Adjusting and calibrating the cultivator

1. Observe an animal drawn planter in operation.
2. Let the facilitator demonstrate to you how the amount of fertilizer applied is adjusted (calibration) on an animal drawn planter.
3. The facilitator will demonstrate to you how to change the seed plates of an animal-drawn planter to suit the required plant spacing.

Animal-drawn spike toothed harrow

This is a secondary tillage implement. A typical animal-drawn spike toothed harrow is shown in Figure 9.7 below.

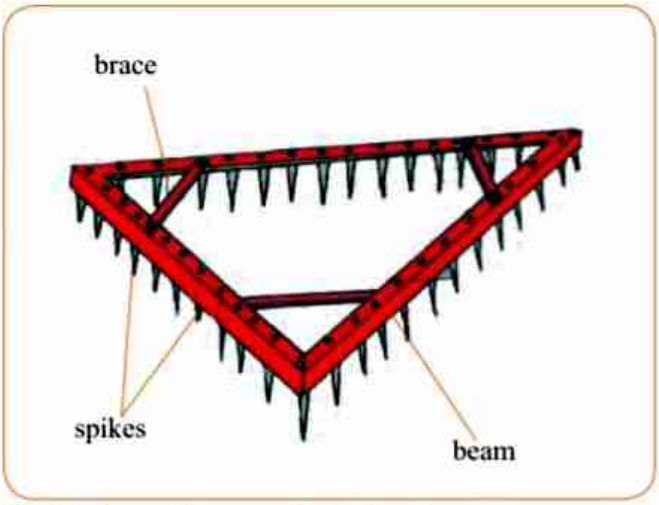


Fig. 9.7 Animal-drawn spike toothed harrow

The animal-drawn spike toothed harrow can be used for the following operations:

- to gather unburied weeds and trash in the field (ploughed or not ploughed)
- for covering seed sown in furrows
- for breaking clods to bring soil (seedbed) to a fine tilth after primary tillage which leaves a rough uneven surface
- for levelling of the land done during secondary tillage

The animal-drawn spike toothed harrow must be pulled by fast moving animals for the breaking of clods and covering of sown seed to be effectively achieved.

Adjustments

The width covered by the animal-drawn spike toothed harrow is not adjustable. This is fixed in the width of the harrow. The width is fixed because the spike toothed harrow frame is a rigid fixed structure. The depth of operation can be influenced slightly by altering the length of the track chain until desired depth is achieved. Weights can be placed on top of the animal drawn spike toothed harrow to force it to go deeper.

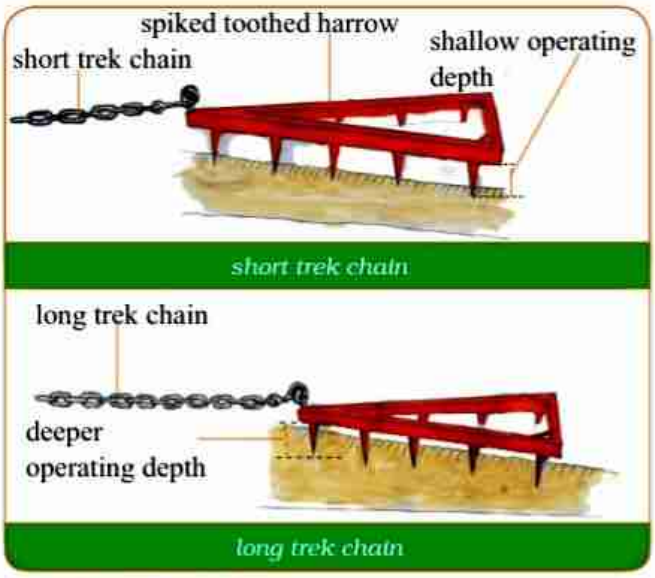


Fig. 9.8 Altering trek chain

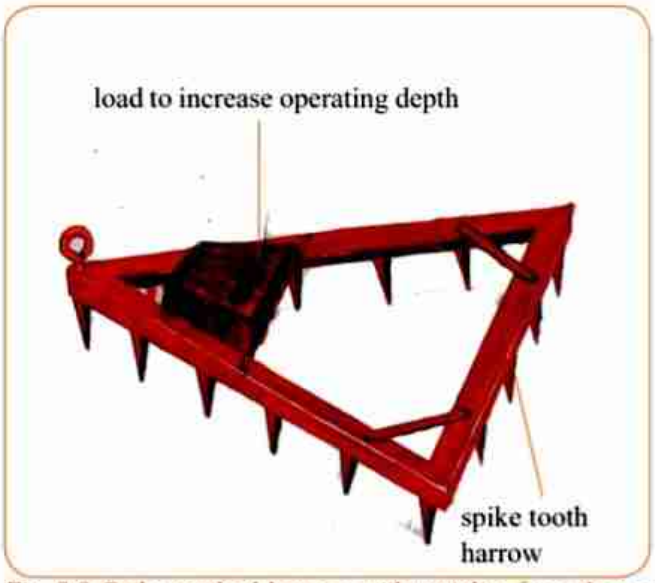


Fig. 9.9 Spike toothed harrow with weights for a deeper depth of operation

Activity 9.4

Practicing routine farm implements maintenance work

With your teacher, go to the tool room, and carry out simple maintenance work on the animal-drawn implements studied, and on some hand tools.

Fencing

A fence is a structure put up to control the movement of people and animals. The restriction is meant to protect people, property, crops and animals. The animals can be domestic, game, or wild. Fencing has the advantage of allowing mixed farming to be practiced on a farm. In this farming practice, animals and crops can be raised on the same farm without negative interference.

Fencing materials and tools

There are many types of fences. Each type of fence is suitable for a specific purpose. Choice of fencing materials is influenced by availability of materials, purpose of fence and level of required security.

Types of fences

There are several types of fence that can be put up on a farm. The types of fences common in Zimbabwe include barbed wire, diamond mesh wire, wooden post and rail, electric wire fence, hedges, precast concrete wall and stone fence.

Barbed wire fence

This fence consists of strands of barbed wire on metal or wooden posts, standards and droppers as shown in Figure 9.10. The spacing of the wire strands from one to the other is determined by the purpose of the fence. In farms with livestock animals such as goats and sheep, the wire strands will have to be closer to restrict animal movement. Metal posts are more durable and last longer when protected from rust. However, they are very expensive. Wooden posts are cheaper. Treated wooden posts should be used where wood is the option. Treated wooden poles are resistant to termite attack. The droppers tied on to the wire strands at regular intervals on the fence help to maintain the distances between wire strands and prevent sagging of wire strands which compromises security. Droppers that can be used can either be wooden or metal.

Fig. 9.10 Typical barbed wire fence

Diamond mesh wire fence

This type of fence is put up where there is need for high level of security and where small farm livestock animals are being reared. The fence is usually made up of diamond mesh wire fixed to metal posts. Some barbed wire strands can also be added above the diamond mesh to restrict movement over the fence. Diamond mesh wire can also be nailed to treated wooden posts. The mesh wire is found in different sizes of the diamond netting. Figure 9.11 below shows a diamond mesh wire fence.

Fig. 9.11 A typical diamond mesh wire fence

Wooden post and rail fence

The wooden post and rail type of fence is entirely made up of wooden material nailed or bolted together. The wood can be treated with creosote to improve termite resistance. Wooden post and rail fence can be of various designs. Below are various wooden post and rail fence designs.

Fig. 9.12 Wooden post and rail fences

Electric wire fence

This fence consists of wooden or metal posts and standards with wires that carry an electric current. The wire gives an electric shock that repels people and animals.

Fig. 9.13 Typical electric wire fence

Live fence (hedges)

These fences are made of lively growing plants as shown in Figure 9.13. The type of plant for use as a hedge should have the following characteristics:

- The plant must have a fast growth rate and must be bushy
- It should not be edible to farm livestock
- Plant must not be poisonous to livestock
- The plant must be drought tolerant and be able to survive harsh conditions

Fig. 9.14 Typical live fence

Precast concrete wall fence

This is made of prefabricated concrete panels inserted into grooves on the side faces of upright concrete posts to form a barricade wall. Figure 9.15 below shows an example of precast concrete wall fence.

Fig. 9.15 A precast concrete wall fence

Stone fence

A stone fence is a wall made of stones. The wall can be dry bonded or mortar bonded. Figure 9.16 shows a dry bonded stone wall and a mortar bonded stone wall.

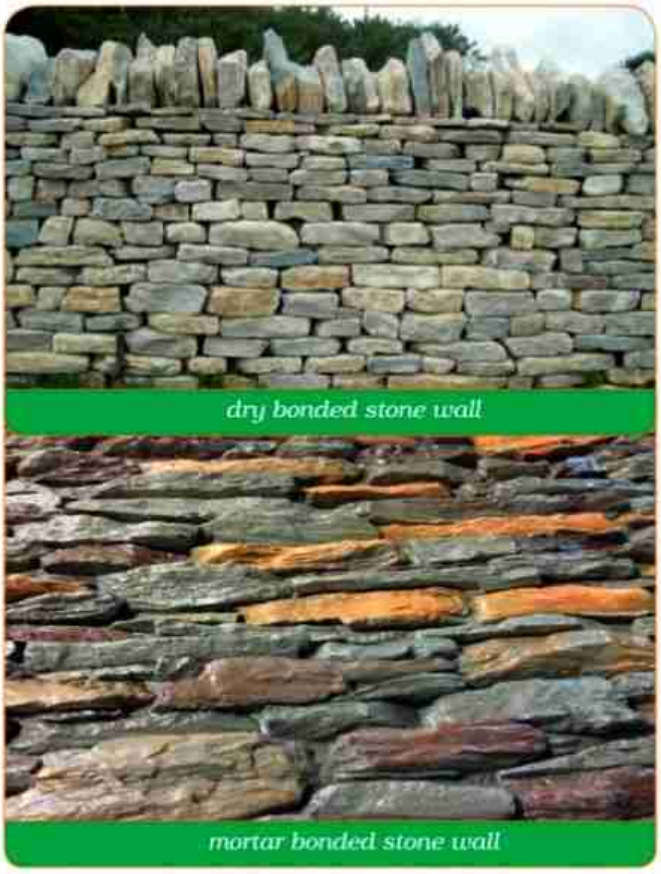


Fig. 9.16 Dry bonded and mortar bonded stone walls

Advantages and disadvantages of different fencing materials

Below are some advantages and disadvantages of materials used to construct the various types of fences described above.

Table 9.1 Advantages and disadvantages of different fencing materials

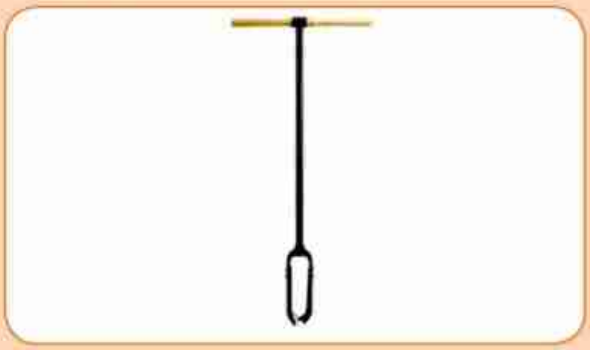
Wire fences: barbed, plain, electric and mesh	
Advantages	**Disadvantages**
• they are durable fence	• very expensive
• easy to erect	• skill is required to erect the fence
• do not need irrigation	• can be dangerous to erect
• easy to change to new requirements	• barbed wire can injure animals
• if metal posts are used, they last long if protected from rusting	• electric fences can be a threat to life
	• may allow in small animals
	• if wooden posts are used, they eventually rot or are destroyed by wood pests
Live fences: hedges	
Advantages	**Disadvantages**
• cheap as planting material can be produced on site	• some hedge plants are poisonous to livestock
• makes property look beautiful	• it takes a long time for hedge to grow to be an effective barrier
• if well-established, it can give privacy to property	• if some plants die they take time to replace and establish
• can make a complete barrier	• hedge needs water and can be killed by drought
• hedges can protect property from strong winds (windbreak)	• plant can provide cover to snakes and rodents
• hedges also reduce soil erosion, especially wind erosion	• it can be easily destroyed by fire
• leaves from the fence can add organic content to soil	
Wooden fences	
Advantages	**Disadvantages**
• not dangerous to erect	• they do not last a long time
• materials are cheaply and readily available locally	• can be affected by wood pests if not well treated

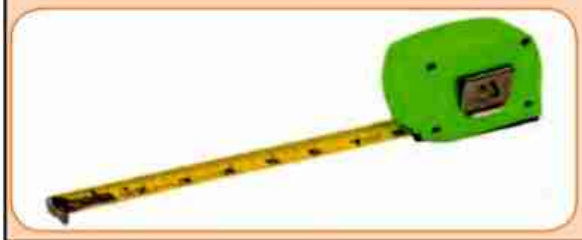
• if the posts are well shaped and painted, they can be beautiful	• rain can make them rot
• if a section is damaged, it can be easily repaired	• if care is not taken, they lead to deforestation as large quantities of wood is required
Wall fences: precast concrete wall, stone wall, brick wall	
Advantages	**Disadvantages**
• make complete barriers	• precast concrete wall can be expensive
• stones are cheap and can be locally available	• the construction of walls is very demanding
• durable walls last long	
• can resist fire or drought	
• provide good windbreak	
• provide privacy	

Fencing tools

Putting up a fence requires various sets of tools that range from digging tools, percussion tools such as hammers, measuring tools, wire straining and tying tools. A wheelbarrow is very important and handy for transporting tools along the fence path. Tools require proper handling and correct use. This will make the tools last longer, working properly. It is therefore important for farmers to know various tools and familiarize with them in order to be able to use the tools safely, correctly and more appropriately.

Table 9.2 Tools for wire fence construction

Tool	Use
Digging bar 	• It is used for digging the holes for erecting the fencing poles or posts
Digging auger 	• Used for digging the holes in place of a digging bar • It resembles a screw and has a drilling effect

Tool	Use
Tape measure 	• The tape measure is used for measuring distances between posts, standards, wire strands and droppers
Axe 	• An axe is used for cutting small bushy trees to clear the path to be followed by the fence
Pick or mattock 	• This tool is used for digging pits for putting large stones for anchoring straining posts on a fence • The mattock is used for stumping along the path of the fence
Shovel 	• The shovel is used to remove soil from pits used for placing stones or concrete for anchoring straining posts • For mixing concrete for supporting straining posts
Wheelbarrow 	• A wheelbarrow is used for carrying materials and tools along as the farmer works along the fence

Tool	Use
Bow saw 	• The bow saw is used for cutting trees along the path of the fence • It is used for cutting wooden posts, standards, and droppers to required lengths
Hacksaw 	• The hacksaw is used to cut metal posts, standards, and droppers to desired lengths
Pliers 	• A pair of pliers is used for cutting wire • It is also used for splicing or joining wire
Claw hammer 	• The claw hammer is used to drive U-nails or staples into the posts to hold the fence • The claws on the hammer are used to remove nails from the posts if there is need to remove the wire strands
Wire strainer 	• The wire strainer is used to pull or strain the wire strands before nailing and throughout the nailing process to fix the wire strands in position

Activity 9.5

Identifying fencing tools

1. From a variety of tools in the tool room, identify the tools used in the erection of a barbed wire fence. Do this under the observation of a facilitator.
2. Draw and correctly name some fencing tools, and for each tool give its uses.

Activity 9.6

School garden fence repair and maintenance

1. Collect tools you would need to use to repair a wire fence from the store room.
2. Identify sections of the wire fence that need to be repaired and the type of repair needed. You may need wire and replacement posts or poles in some cases.
3. Using the correct tool for the right job, carry out the fence maintenance tasks as required.

Tools should be used safely. Carry a few tools at a time. Do not run whilst carrying tools and always pay attention to the task you will be doing using a particular tool.

Farm roads

Farm roads are a very important network that link critical points on the farm. A road network allows the farm to be reached easily by passenger vehicles, tractors, delivery vehicles and scotch carts. Footpaths are not good on the farm as they may cause erosion, so their use must be minimized. For the roads to safely and effectively serve their purpose, they must be well sited and should meet certain standards.

Fig. 9.17 a) A farm permanent road *b) A farm feeder road*

Factors to be considered when siting a farm road

Operations of the farm: These are the major activities carried out at the farm. Some farms may be dealing with bulk farm produce which will need heavy trucks. This will mean need for wider roads.

Areas of the farm to be linked by the road: At a farm, numerous points may need to be linked. For example, linking different farm plots or linking the farm with the processing plant, market or source of inputs.

Topography of the land: The terrain is also important to consider. Very steep surfaces are costly to construct a road.

Type of the road (feeder or permanent road): Where the road is just a feeder, it can be small. A permanent road needs to be big and well-constructed.

Rivers or streams to be crossed: When siting, the road needs to avoid crossing too many rivers to reduce cost of constructing bridges.

Equipment used when siting farm roads

Siting of roads requires specialized equipment for surveying. The road should follow a particular course that offers safety to its users. Surveying equipment such as staff and dumpy level require special skills and knowledge. Care should be taken when using surveying equipment. This is because some of the equipment is very expensive and delicate. Table 9.3 shows the equipment used when siting farm roads.

Table 9.3 Equipment used when siting farm roads

Equipment	Uses
Dumpy level 	• It is an optical instrument used to establish or verify points at the same level • Used to measure height differences • Dumpy level is used to measure and set heights
Staff 	• Also called leveling rod • It is a graduated aluminium or wooden rod used to determine differences in height between two points

Equipment	Uses
Surveying chain (Gunter's chain) 	• A chain of known number of links used to measure distances for land surveys
Tape measure 	• Used for measuring and determining distances
Hammer 	• Driving in pegs to mark the road site
Axe 	• Clearing bushy shrubs
Bow saw 	• Cutting trees along the path

Characteristics of a well sited farm road

- A well sited road follows the crest or watershed areas for good drainage.
- A farm road that is well sited, makes the shortest distance possible between any two points to be connected. This minimizes cost of construction or maintenance of the farm road and travelling costs are also reduced.
- The road offers all weather access with ease and safety.

Harnessing

Harnessing is the tying or connection of animals with equipment that enable them to pull loads and implements. The loads may include ploughs, cultivators, planters, ridgers, harrows, water carts and scotch carts. An animal can be harnessed single, in pairs or in fours. Animals that are usually harnessed are oxen, donkeys, horses, and of late buffalos.

Different types of harnesses are used for different animals depending on their muscular distribution. There are breast bands and collar harnesses. Breast bands are used for donkeys and horses because they provide their pulling power by pushing with their breasts. Oxen and buffalo are harnessed with neck or wither yokes because they provide pulling power by pushing with their humps or withers as they move forward.

Harnesses for oxen

Collar harnesses (neck yoke)

This is a very common harness in Zimbabwe. It is made up of a shaft and skeis of wood. It has clamps made of metal. Strops are used to secure the yoke onto the necks of the animals and these can be made of hides or rope or tree bark string.

A trek chain that connects the yoke to the implements such as plough, planter and harrow is made of metal. The neck or collar yoke can be single neck or double neck yoke. The two types of neck yokes are shown below.

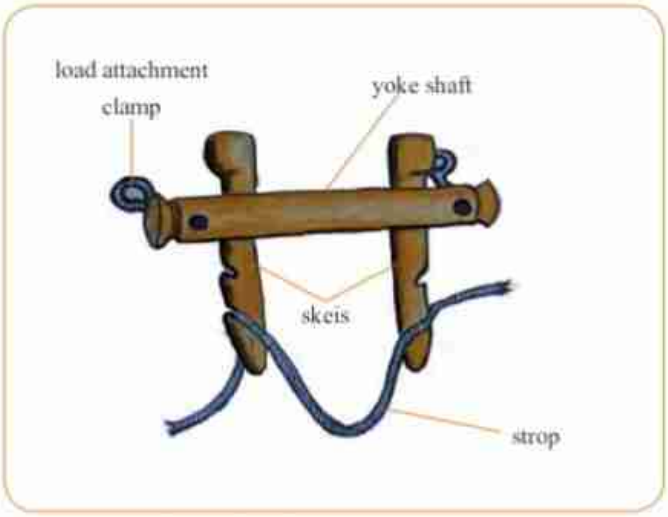


Fig. 9.18 Single neck yoke

Fig. 9.19 Single neck yoke in use

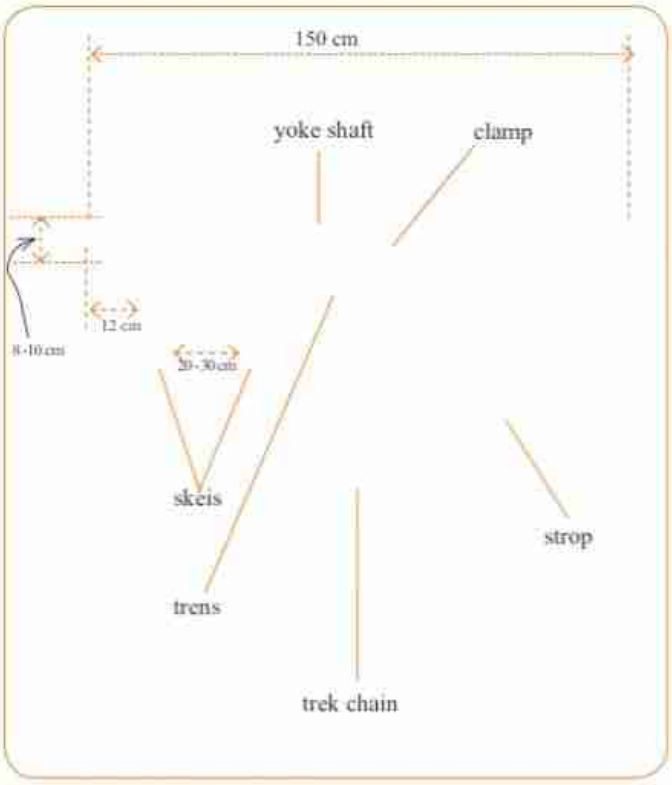


Fig. 9.20 Double neck yoke

Fig. 9.21 Double neck yoke in use

Breast band

The horse and donkey harnesses

The breast band type of harness is used on donkeys, mules, or horses which use wither muscles. This harness is made from bands of materials such as hides, old-light used car tyres, canvas, or strong tent. The breast band harness is shown in Figure 9.22.

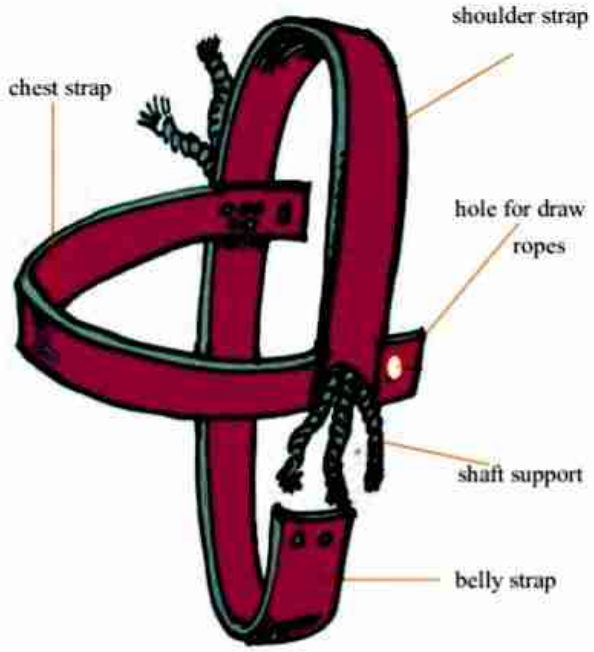


Fig. 9.22 A breast band

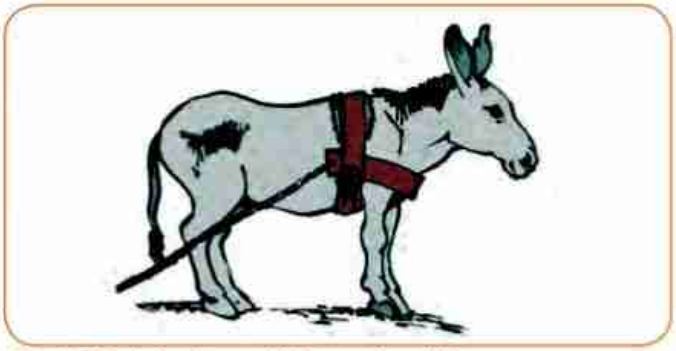


Fig. 9.23 A donkey with breast band harness

Activity 9.7

Designing and making models of harnesses

1. With the help of a facilitator, choose and construct either a model or the actual donkey harness.
2. Make sketches of possible neck yoke designs. Select the best design, further develop it and make a model or the actual double neck yoke for oxen.
3. Investigate on materials for making harnessing equipment that can be used as substitute to wood.

Summary

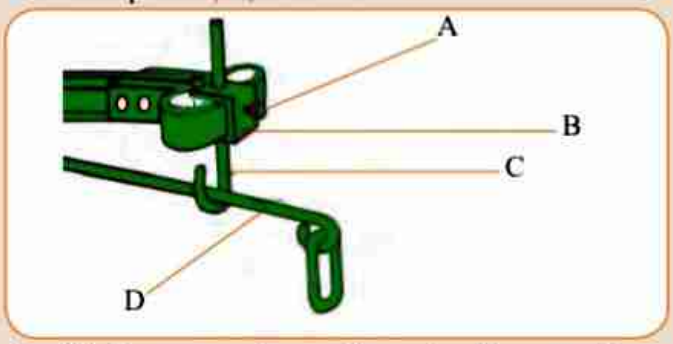
- Animal drawn implements use animal power to operate. Examples of commonly used animals to pull implements include horses, mules, donkeys and oxen.
- Animal drawn implements need adjustments to attain desired operational depth or width.
- Shortening of trek chain on an implement makes the depth of the cut shallow and likewise, lengthening the track chain increases the depth of cut of the implement.
- A fence is a structure or barrier put up to surround property.
- There are several types of materials that can be used to put up fencing structures. These include wire fences, live tree hedges, precast and built up walls.
- Fences are used on farms to restrict unsanctioned movements by animals and people. This protects crops, livestock and other property.
- Wire fences are expensive but more durable than wooden fences.
- Stone walls last longer.
- Wood and metal poles used in fencing need protection to last longer.
- Tools for fencing need correct identification and should be used for the right purpose or job.
- Farm roads form a transport communication network to link critical points on the farm.
- Proper roads must be constructed and maintained for easy access between points on the farm.
- Factors to be considered when siting farm roads include facts on daily farm operations, areas to be linked, topography, rivers or streams to be crossed and the type of the road required.
- Well-made and maintained roads will not cause soil erosion.
- A well sited road follows the crest, offers all weather access, connects two points using the shortest possible distance.
- Breast bands are meant for donkeys and horses because they use breast muscles.
- Collar harnesses or neck yokes are used for oxen with wither muscles.
- Harnesses can be made from wood, leather, canvas and used tyre material.
- Materials for harnesses must be light, strong and durable.

Glossary

Creosote : a chemical used to treat wood to improve termite resistance
Droppers : metal or wood pieces tied to wire strands suspended to maintain distance between wire strands
Dry bonding : making brick or stone structures without using mortar
Posts : wooden or metal lengths buried upright in the ground to support fencing wire
Soil clods : lumps of soil
Topography : appearance of the land surface

End of chapter questions

1. What is the effect of lengthening and shortening the trek chain on a cultivator or spike toothed harrow?
   A. alters cutting depth
   B. widens the cutting width
   C. repairs the implement
   D. speeds up operations
2. The cultivator width is adjusted using:
   A. trek chain
   B. adjusting lever
   C. hitch assembly
   D. wheel position
3. Which of the following is not a reason for fencing?
   A. to mark boundaries
   B. to restrict animal movement
   C. to allow mixed farming
   D. to allow crop irrigation
4. A dumpy level is an instrument used for:
   A. measuring difference in height between two points
   B. measuring distance between two points
   C. marking straight lines
   D. leveling land
5. Select a correctly paired set of animal and type of harness.
   A. donkey; double neck yoke
   B. donkey; collar neck yoke
   C. oxen; breast band
   D. horse; breast band
6. Discuss how the cutting depth of a mouldboard plough can be adjusted. [4]
7. List any five tools needed to put up a new wire fence and give their correct uses. [10]
8. Discuss the advantages and disadvantages of live fences or hedges. [6]
9. What are the factors to be considered when siting a farm road? [5]
10. Give the characteristics of a well sited farm road. [3]
11. Name any four tools or equipment used for the siting of farm roads. [4]
12. Draw and label the parts of a breast band harness. [5]
13. Draw and label the parts of a double neck yoke. (10)
14. Label the parts A, B, C and D on a mouldboard hitch assembly.



15. Explain the reason why a collar neck yoke cannot be used on a donkey.

CHAPTER 10 Agri-business

Chapter objectives

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

- explain the functions of the profit and loss account
- design a profit and loss account
- identify the income and expenditure of a farm enterprise
- calculate the income from an agriculture enterprise
- distinguish between controlled and uncontrolled markets
- describe formal and informal markets for major crops and livestock in Zimbabwe
- explain benefits of agricultural cooperatives
- identify problems associated with agricultural cooperatives

Key concepts

- Profit and loss account
- Types of markets
- Cooperatives

Introduction

Agriculture is a viable occupation where financial gain is secured. Economic principles apply to agricultural business activities. When properly applied, farming can be very productive. Gone are the days when farming was taken as a hobby. Now farming has become a business and as such, every input, output and activity must be accounted for. The agricultural financial management aspect is taken care of by the agri-business component of farming.

Profit and loss account

Introduction

Profit and loss account is a financial record of the money that comes into the farm (income), and the money that goes out of the farm (expenditure).

Income on the farm may come from the sales of crops, livestock, or livestock products. Expenditure arises from the payment for inputs such as seed, fertilizers, feeds and chemicals. Wages and salaries, repairs of machinery, fuels and many other paid for items are part of the farm expenditure.

A comparison of the income and expenditure of the farm will reveal to the farmer the profit or loss made by the farm business or by the different farm enterprises. The profit and loss account will help the farmer to be able to decide on which enterprises to drop or continue with, depending on their levels of profit or loss. The profit or loss is indicated by the two possible outcomes below:

- If income is greater than expenditure, the farmer has made a profit.
- When expenditure is greater than income, the farmer has made a loss.

Calculations to determine profit or loss

Profit

Profit is made when income from sales is greater than the expenditure from input purchases and other paid for services directly linked to production. The farmer will have made profit because more money has been made from smaller amount invested in production. Profit is calculated as follows:

Income - Expenditure = Profit

Loss

The farmer makes a business loss when the expensed money on the enterprise is greater than money earned from the agro-sales. This means that money used to buy

inputs and pay for expenses for the farm enterprise was more than money made from the sales of the agricultural product produced. The business loss is calculated as indicated below:

Expenditure - Income = Loss

Breakeven

Breakeven is when the income and expenditure are equal. The farmer has not made a profit, and has also not made a loss. In that case the farmer has had a breakeven. The breakeven is presented as in the equation below.

Income = Expenditure = Breakeven

Profit and loss account

The profit or loss of a farm is calculated in the profit and loss account. The following is an example of the profit and loss account showing the income and expenditure account of an egg production enterprise.

Table 10.1 Example of a profit and loss account

Income/Returns	Amount	Expenditure/Cost	Amount
Eggs sold	$4000	100 x point of lay pullets	$1200
Eggs home consumption	$ 380	Layers mash	$2100
Off-layers sold	$ 400	Drugs	$100
Total income	$4780	Total expenditure	$3400
Difference ($4780 - $3400) = (profit) $1380			

Income - Expenditure = Enterprise profit
Total income = $4780
Total expenditure = $ 3400
$4780 - $3400 = **$1380 (profit)**

In the above illustration of a profit and loss account, the total income is greater than the total expenditure by $1380,00 so there is a profit of $1380,00 from the egg production enterprise.

The following table illustrates the profit and loss account for 5ha green mealies production enterprise.

Table 10.2 Example of a green mealies production profit and loss account

Name of field _____		Hactarage 5ha	
Income/Returns		**Expenditure/Cost**	
Sell of green cobs @ $1 for 10	$18500	Seed 5 x 25kg	$ 500
		Lime 50 x 50kg	$ 350
		Fertilizers – compound D – ammonium nitrate	$ 240 $ 140
		Transport (fertilizer and lime)	$ 100
		Herbicides	$ 30
		Pesticides	$ 50
		Tractor fuel 125 litres	$ 140
		Casual labour x 5	$3000
Total income	**$18500**	Total expenditure	**$4550**
Difference $18500 - $4550 = $13950			

Income - Expenditure = Enterprise profit
Total income = $18 500
Total expenditure = $ 4 550
$18 500 - $4 550 = **$13 950 (profit)**

The income is greater than the expenditure by $13 950. Therefore, there is a profit of $13950 made by the farmer in the green mealies production enterprise after investing $4 500.

After calculating the profit for each enterprise on the farm, the profit for the whole farm can be calculated. This is done by adding the profits from the different enterprises together, and subtracting the general farm expenditure. General farm expenditure, known as **fixed costs,** is expenditure on the farm not directly related to individual enterprises, but relate to the function of the farm as a whole. Examples of such costs are manager's salary, salaries of workers who work across enterprises, rent, access road maintenance, and telephone bills, amongst other costs.

The whole farm profit and loss account will look like Table 10.3.

Table 10.3 Example of a whole farm profit and loss account

Mr Matura Gukwe's farm profit and loss account (Year 2017)			
Income/Returns/Revenue		**Expenditure/Costs**	
Green mealies enterprise	$18 500	Green mealies enterprise	$ 4 550
Egg production enterprise	$4 780	Egg production enterprise	$3 400
		Fixed/general costs	$8 400
Total income	**$23 280**	Total expenditure	**$16 350**
Difference	**$ 6 930**		

The profit for the whole farm will be calculated as follows:
Total income - total expenditure = whole farm profit
$23 280 - $16 350 = **$6 930**
Because the total income is greater than total expenditure, the difference is a profit for the whole farm.

Activity 10.1

Designing a profit and loss account

1. a) In groups, identify and list crop enterprises found in your school farm.
   b) Find out and list all the costs/expenditure involved in each enterprise separately.
   c) Using current market values, calculate the income/returns expected from the selling of crops from each of the enterprises.
   d) Using the information gathered, calculate the profit or loss for each of the enterprises listed.
2. Identify and list down the possible fixed costs of your school farm.
3. Make a profit and loss account for your school agriculture enterprise.

Marketing

Agriculture marketing is mainly the buying and selling of agricultural products. This takes place at a market place. Commercial farmers should study the pattern on the market for which they want to produce commodities for. This is to enable them to supply commodities to the market when the market prices are favorable. Agricultural markets in Zimbabwe can either be private or national marketing Boards such as Grain Marketing Board.

Marketing is a process. Before commodities or goods and money change hands, several activities take place. Such activities include grading, packaging, transporting, advertising, and storage. If one of these is not good, a farmer may lose money. For example, a poorly graded or packaged product may not sell well. If there is no good transport system, the product may perish in the hands of the farmer or before it gets to the market. If a product is poorly advertised, potential customers may not know of it.

Selling of any agricultural produce depends on a number of factors such as demand of the produce at that time, availability of storage facilities and quality. The produce may be sold directly in the market or it could be stored

before it is sold. Farm produce may also be cleaned, graded, packed or processed by the farmer before selling it.

Types of markets

Markets for various commodities or agricultural produce may be controlled or uncontrolled.

Controlled markets

A controlled market is a set up where the marketing of specified goods or commodities produced is controlled by the government or a marketing board. Usually the prices of the commodity are predetermined by the government or a marketing board. So, in this case, farmers know before producing how much returns to expect, based on their level of production.

In Zimbabwe, boards such as the Grain Marketing Board (G.M.B.), Dairy Marketing Board (D.M.B.), Cotton Marketing Board (C.M.B.), Cold Storage Commission (C.S.C.), Tobacco Marketing Board (T.M.B.) control the marketing of certain products or commodities as shown in Table 10.4. These marketing boards will be the sole buyers of such agricultural commodities and would then sell the produce to manufacturers, processers or final consumers.

Table 10.4 Examples of marketing boards and commodities they handle

Marketing board	Commodity	Sold to
Grain Marketing Board (G.M.B.)	• All grains such as maize, wheat, rapoko, millet, soghurm, groundnuts, roundnuts • oil seeds • wheat • coffee	• millers and the public • oil processers • millers • processors of stockfeeds
Cotton Marketing Board (C.M.B.)	• cotton seed • cotton lint	• oil expressers • farmers • spinners
Cold Storage Commission (C.S.C.)	• livestock for slaughter	• public butcheries
Dairy Marketing Board (D.M.B)	• milk	• shops • public.

Uncontrolled markets

In an uncontrolled market, a farmer sells the farm produce to a market of his or her own choice. It can be wholesalers or directly to consumers. Prices are not predetermined, instead, they are controlled by the forces of supply and demand. Prices will go up if supply does not meet demand. If there is over supply on the market, prices will generally go down.

Markets can also be classified as formal or informal.

Formal markets

These are regular, well established, well organized and officially recognized markets for particular agricultural products. Examples are the marketing boards. Below are various marketing boards and the products they buy from farmers.

- T.M.B. (Tobacco Marketing Board) – tobacco
- G.M.B. (Grain Marketing Board) – maize, wheat, groundnuts, soyabeans, sunflower, rapoko, sorghum, mhunga, beans, coffee.
- C.M.B. (Cotton Marketing Board) – cotton lint.
- C.S.C. (Cold Storage Commission) – livestock.
- D.M.B. (Dairy Marketing Board) – milk.
- Colcom Zimbabwe – pigs.

tobacco auction floor

Fig. 10.1 Farmers at a formal market

Informal markets

These are markets where no fixed procedures are followed. The suppliers of commodities and buyers negotiate for a price. The suppliers and buyers can meet in public market stalls like the ones run by district council, town or city councils.

Traders can meet privately and conduct business. It can be on the farm, in the street, in a retailer's shop and many other places.

Fig. 10.2 Farmers at an informal market

Activity 10.2

Identifying locally produced agricultural products and their marketing

Work in groups to do the following:

1. Make a list of not less than five commodities (crop and livestock) produced in your area.
2. Discuss how the commodities you have listed are marketed in your area. Make it clear whether the marketing is controlled or uncontrolled.

Agricultural cooperatives

In a cooperative, people work together for a common goal. In an agricultural cooperative, the work done is related to agriculture. Cooperatives are named according to their functions, or the problems they are meant to solve as shown in Table 10.5.

Table 10.5 Types of agricultural cooperatives

Type of cooperative	Function
Savings cooperative	• Farmers put their monies together for a period of time until a target amount is reached. They may then share the money at the end of the period, or use it to buy inputs.
Purchasing cooperative	• Farmers come together to put money into a common pool so that they will raise enough money to buy inputs in bulk and enjoy discounts. • Farmers may put money together to buy large equipment they may not be able to buy as individuals, for example, a tractor which will be used by all members of the cooperative, or a good breeding bull for all the cooperative members.
Producers cooperatives	• In this cooperative, people come together to produce a commodity together. For example, people owning small pieces of land may not be able to raise beef cattle as individuals. If these people come together and join their pieces of land, they will easily be able to raise beef cattle. This is possible with any commodity.
Marketing cooperative	• Individual farmers may have problems in the following areas: grading, storage, transport, advertising, and finding markets. • If farmers market their crops as a cooperative, they will be better able to handle the problems than individuals.

Besides the above-named cooperatives, farmers can also come together and form cooperatives to overcome any other agricultural problem such as tillage, planting, pest control and many other related problems.

Benefits of agricultural cooperatives

- Farmers buy inputs in large quantities and get discounts.

- Agricultural cooperatives create room for sharing of skills.
- Cooperatives are registered organizations. Farmers who are members have better chances of getting loans as a cooperative than as individuals.
- Transport costs are reduced when the farmers transport their produce in bulk.
- It is cheaper to put up larger storage facilities than many small storage facilities as individuals.
- In a cooperative set up, farmers can get information easier and quicker than as individuals.

Problems of cooperatives

- There may be disharmony, if a cooperative is made up of members from different backgrounds.
- If there is insufficient capital to support the goals of the cooperative, it will fail.
- Leaders of cooperatives may misuse funds.
- There may be a lack of essential skills among members.
- Members may lack commitment and fail to commit themselves fully to the demands of the cooperative.

Activity 10.3

Survey to identify cooperatives, their problems and possible solutions

1. Carry out a survey in your area and identify, by name, at least two agricultural cooperatives.
2. Discuss with the leaders of the cooperatives the problems they are facing.
3. In class, discuss the problems of the cooperatives you have identified and try to come up with solutions you can recommend to the cooperatives.

Summary

- In studying agri-business, you become knowledgeable of farm records and their importance, marketing and co-operatives.
- Farm records are important as they help the farmer to identify the most rewarding path to follow.
- Profit and loss account is a financial record of the money that comes into the farm (income) and the money that goes out of the farm (expenditure).
- Profit is made when income from sales is greater than the expenditure from input purchases and paid for services linked to production.
- A farmer makes a business loss when the expensed money on the enterprise is greater than money earned from sales of the farm products.
- Breakeven is when the income and expenditure are equal. The farmer will neither have made a profit nor a loss.
- Agriculture marketing is mainly the buying and selling of agricultural products.
- Marketing is a process which is preceded by activities such as grading, packaging, transporting, advertising, and storage before exchange of money and goods takes place.
- In the marketing system there are controlled and un-controlled markets.
- A controlled market is a set up where the marketing of specified goods or commodities produced is controlled by the government or a marketing board and prices are predetermined.
- In an uncontrolled market, farmers sell the farm produce to a market of their own choice.
- Markets can be described as formal markets and non-formal markets.
- Formal markets are regular, well established, well organized and officially recognized markets for particular agricultural products.
- Informal markets are markets where no fixed procedures are followed. The suppliers of commodities and buyers negotiate for a price.
- In a cooperative, people work together for a common goal.
- Cooperatives are there to make work lighter through combining effort.
- Cooperatives are named by the purpose they are created to perform.
- Cooperatives have associated benefits and problems.

Glossary

Enterprise : a single entity of agricultural business that operates separately but contributes to the whole farm income

Tillage : organized and planned disturbance done to the soil in preparation for growing crops

End of chapter questions

1. The farm financial aspect of management is dealt with through:
   A. agronomy B. marketing
   C. agri-business D. reserve bank
2. Which statement correctly describes breakeven?
   A. income is greater than expenditure B. expenditure is greater than income
   C. income is equal to expenditure D. income is broken into half of expenditure
3. What is the function of a producer cooperative?
   A. farmers group to buy produce
   B. farmers come together to produce a commodity
   C. farmers form a cooperative with producers
   D. to encourage farmer unity
4. Which of the following marketing boards deal with tobacco?
   A. G.M.B. B. C.M.B. C. T.M.B. D. T.A.B.
5. A farmer makes a total income of $40 000 from soya bean sales after purchasing inputs and paying for services at a cost of $9 000. What is the farmer's profit?
   A. $31 000 B. $49 000 C. $9 000 D. $40 000
6. Distinguish between controlled and uncontrolled agricultural markets. [2]
7. List any four importance of farm records. [4]
8. Differentiate physical farm records from financial farm records. [4]
9. a) Calculate and complete the profit and loss account for Sophia farm.

Sophia farm profit and loss account for year 2016			
Income/Returns/Revenue		Expenditure/Costs	
Soya bean enterprise	$ 19 500	Soya bean enterprise	$ 4 350
Dairy milk enterprise	$ 7 220	Dairy milk enterprise	$ 4 000
Onion enterprise	$ 5 500	Onion enterprise	$ 1 720
		Fixed/general costs	$ 8 400
Total income	$ ……	Total expenditure	$……
Difference (profit/loss/ breakeven)		$ ……	

[6]

   b) Did the farmer make a profit, loss or breakeven? Justify your answer. [2]
10. Briefly outline how the profit and loss account is important to the farmer. [5]
11. Explain at least five benefits of agricultural cooperatives. [5]

12. Identify at least five problems associated with agricultural cooperatives, and suggest possible solutions to the problems. [10]
13. Discuss the difference between a controlled and uncontrolled market. [4]
14. Complete the following table:

Name of field_____	Hactarage 3ha	
Income/Returns	**Expenditure/cost**	
Sell of green cobs @ 1$ for 10: $21500	Seed 5 x 25kg	$ 300
	Lime 50 x 50kg	$ 450
	Fertilizers - compound D - ammonium nitrate	$ 340 $ 240
	Transport (fertilizer and lime)	$ 300
	Herbicides	$ 60
	Pesticides	$ 70
	Tractor fuel 125 litres	$ 180
	Casual labour x 5	$3000
Total income $.....	Total expenditure $.....	
Difference = $.....		

[6]

15. Define marketing and give two examples of possible markets for fresh vegetables. [3]

Specimen Paper 1

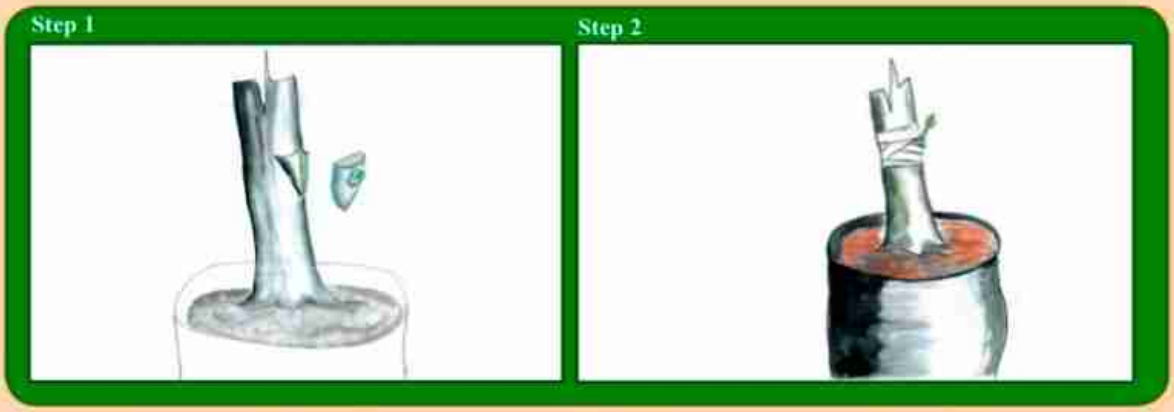
Multiple choice

1. Population density refers to:
   A. increase in population
   B. number of inhabitants per unit area
   C. total land that belongs to a country
   D. total population
2. Which of the following pairs is made up of types of farming systems?
   A. mixed farming, cattle farming
   B. monoculture, mixed farming
   C. intercropping, cattle farming
   D. vegetable farming system, animal farming
3. Population growth can be controlled by which of the following methods?
   A. family planning awareness campaigns
   B. killing new born babies
   C. prohibiting marriages
   D. control
4. What is the practice of growing maize and bean crop on the same field at once?
   A. mixed farming
   B. monoculture
   C. intercropping
   D. 2 crop farming
5. Which environmental factor is managed by tied ridging?
   A. high rainfall
   B. low rainfall
   C. hailstorm
   D. temperature
6. Select a list with hardwood forest trees.
   A. mukwa, Zimbabwean teak, mahogany
   B. pine, saligna gum tree, wattle
   C. wattle tree, pine tree, mahogany
   D. Zimbabwean teak, saligna gum, pine tree
7. What is the purpose of a fire guard around tree plantations and tree nurseries?
   A. to maintain fire
   B. to create fires
   C. to prevent spread of fires
   D. for preventing termites
8. Indigenous hard wood trees have a problem of:
   A. growing straight
   B. being very expensive
   C. taking long to mature
   D. maturing early before they are strong
9. What are endangered animals?
   A. dangerous animals
   B. animals near extinction
   C. problem animals
   D. animals that eat other animals
10. How does use of animal totems affect wildlife?
    A. may result in the animals disappearing
    B. helps to conserve some animals
    C. endangers some animals
    D. creates meat for chiefs only
11. Select a problem animal.
    A. baboon
    B. lion
    C. rhinoceros
    D. python
12. The soil profile shows:
    A. horizontal arrangement of soil layers
    B. vertical soil layers arrangement
    C. fertility levels of soil
    D. soil pH
13. A straight fertilizer supplies:
    A. two major nutrients
    B. single major nutrient
    C. three minor nutrients
    D. three major nutrients
14. Which horizon of the soil profile supports plant growth?
    A. top soil
    B. subsoil
    C. parent rock
    D. humus
15. A compound fertilizer can best be described as:
    A. compound D
    B. fertilizer with more than one nutrient
    C. fertilizer with a single nutrient
    D. top dressing fertilizer

16. The seed shown can be classified as…

A. monocotyledonous B. dicotyledonous C. broad bean D. seed structure

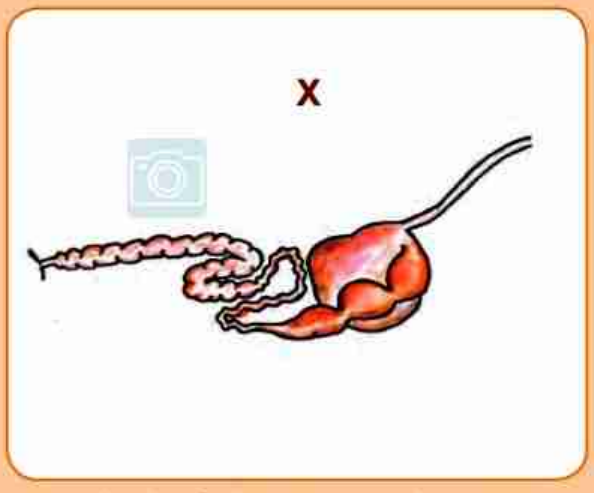
17. Monocotyledonous leaves have which of the following given shapes?
    A. broad shaped B. narrow shaped
    C. both broad and narrow shaped D. none of the given shapes
18. Select a legume from the given crops.
    A. peas B. onion C. cabbage D. tomatoes
19. Which of the following crop is from the graminae family?
    A. maize B. groundnut C. beans D. rape
20. Sexually reproduced plants are reproduced by means of:
    A. seed B. rhizome C. cutting D. stolon
21. The diagrams illustrate which method of vegetative reproduction?

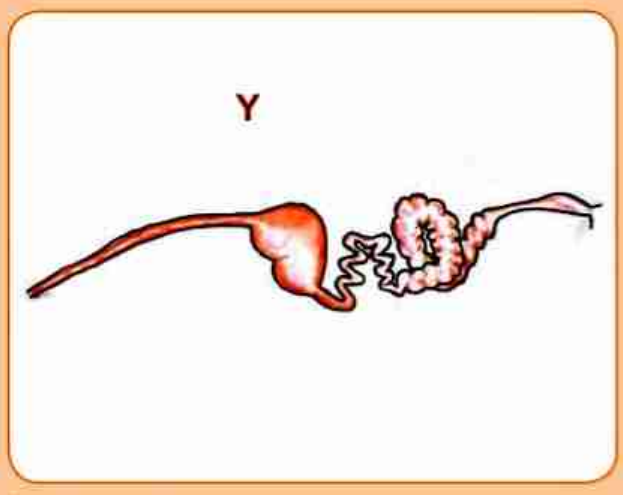


A. budding B. grafting C. joining D. cutting

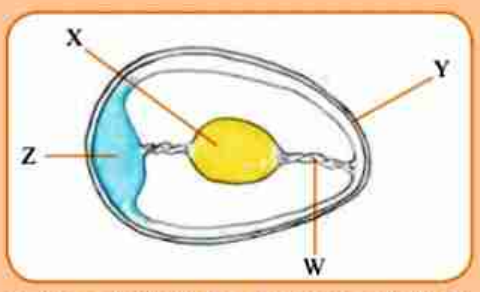
22. What are the requirements for germination to take place?
    A. water, carbon dioxide, sunlight B. water, oxygen, optimum temperature
    C. high temperature, carbon dioxide, water D. oxygen, water, low temperature
23. Select a pattern which is not used when planting orchard trees.
    A. square pattern B. quincox
    C. staggered pattern D. octagonal
24. Select a deciduous fruit from the given fruits.
    A. apple B. mango C. avocado D. orange
25. Cavendish is a cultivar of which fruit?
    A. orange B. banana C. apple D. peach
26. Which statement correctly describes complete metamorphosis?
    A. there is a complete change in body shape B. there is no change in shape
    C. no change in body size D. no gain in body mass
27. What is a vector insect?
    A. an insect which transmits diseases B. an insect which causes diseases
    C. an insect which feeds on animals D. a problem insect

28. An annual weed is a:
    A. a plant completing its life cycle in one year
    B. a plant completing life cycle in two years
    C. a grass plant
    D.a broadleaved weed
29. The following pests undergo complete metamorphosis except:
    A. moth B. butterflies C. locust D. fruit fly
30. All are fungal diseases of plants except:
    A. late blight
    B. angular leaf spot
    C. downey mildew
    D. grey leaf spot
31. The diagrams show the digestive systems of livestock animals.



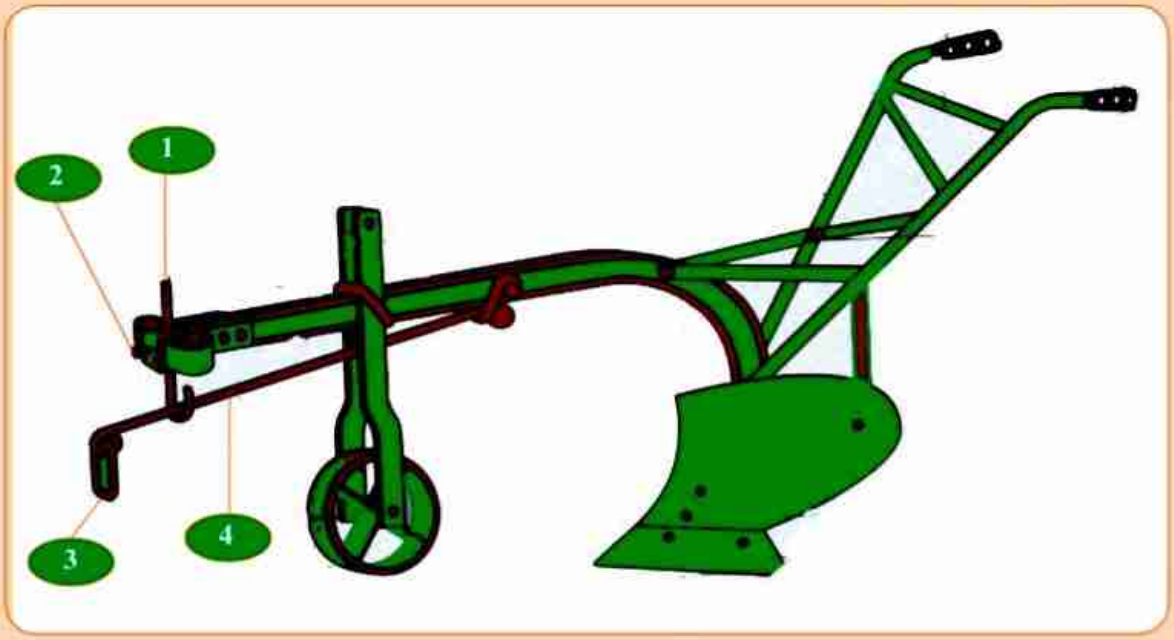


    Correctly identify the ruminant and non-ruminant digestive system.
    A. X = ruminat, Y = non-ruminant
    B. X = non ruminant Y = ruminant
    C. X = ruminant, Y = ruminant
    D. X = non ruminant Y = non-ruminant
32. What is the importance of small stones in the gizzard?
    A. it is food to the animals
    B. grinds food particles
    C. they are dangerous to poultry
    D. they work with enzymes
33. Why is a rabbit able to digest fibrous foods?
    A. it has a rumen that breaks down fibres
    B. it has four stomach chambers
    C. it has a large caecum containing bacteria that breaks down cellulose
    D. it chews the food
34. Below is the structure of an egg. Correctly identify the labelled parts W, X, Y and Z



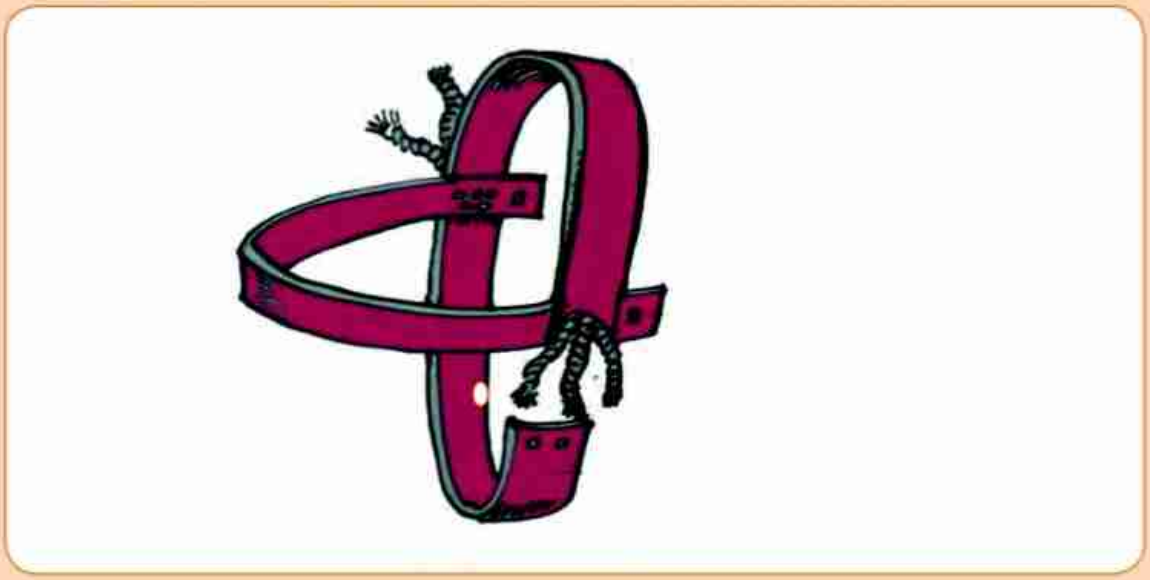
    A. W = chalaza, X = York, Y = shell, Z = airspace
    B. W = airspace, X = York, Y = shell, Z = chalaza
    C. W = chalaza, X = York, Y = membrane, Z = airspace
    D. W = twister, X = York, Y = shell, Z = airspace
35. Lack of some essential nutrients results in:
    A. biological disease
    B. nutritional diseases
    C. physical injuries
    D. poisoning

36. Identify the labelled parts on a mouldboard plough.



A. 1= depth rod, 2 = set screw, 3 = link, 4 = draw bar
B. 1= depth rod, 2 = draw bar, 3 = set screw, 4 = link
C. 1= link, 2 = draw bar, 3 = set screw, 4 = depth rod
D. 1= set screw, 2 = draw bar, 3 = link, 4 = depth rod

37. Identify what is shown on the diagram.



A. breast band B. mouthguard C. neck yoke D. collar yoke

38. What is the function of a producer cooperative?
A. farmers group to buy produce
B. farmers come together to produce a commodity
C. farmers form a cooperative with producers
D. to encourage farmer unity

39. Marketing mainly involves
A. grading B. marketing boards C. crediting D. buying and selling

40. When farmers come together and put their resources to buy inputs at once, their type of cooperative is known as
A. savings cooperative
B. purchasing cooperative
C. marketing cooperative
D. producers cooperative

Specimen Paper 2

SECTION A [70 marks]

1. a) Name any one form of agricultural land use found in Zimbabwe. .....
.....
..... [1]

b) Define population .....
..... [2]

c) Calculate the population density for a country with a total area of 390 760km^2 and a population of 13 million people. ..... [3]

d) Discuss the effects of population increase on agricultural activities. .....
..... [4]

2. a) Define the following farming systems:

(i) Monoculture.....
..... [1]

(ii) Mixed farming.....
..... [1]

(iii) Intercropping .....
..... [1]

b) Outline the advantages of intercropping. ..... [5]

c) What are the disadvantages of intercropping?..... [2]

3. a) Discuss methods and ways that can be used to reduce the effects of little or low rainfall to farming activities. .....
.....
..... [3]

b) List the major environmental factors that influence agricultural activities. .....
..... [4]

c) Discuss the influence of humidity to cropping activities. .....
..... [3]

4. Draw an illustration of the soil profile and label all the horizons giving their typical characteristics. [10]

5. a) What is the importance of irrigation to agriculture? .....
..... [6]

b) Outline the factors that affect the quality of water for agricultural purposes. .....
..... [4]

6. a) List the six important nutrients required by livestock. ..... [6]

b) Suggest four ways through which pathogenic diseases can be transmitted. ..... [4]

7. a) Complete the following profit and loss account for a school farm in Mutoko. Indicate whether profit or loss was made.

Income/Returns	Amount	Expenditure/Cost	Amount
Eggs sold	$3000	100 x point of lay pullets	$1230
Eggs consumed	$ 80	Layers mash	$2400
Off-layers sold	$ 410	Drugs	$120
Total income	$.....	Total expenditure	$.....
Difference = $.....			

[4]

b) Describe the types of markets for agricultural products. .....
..... [4]

c) Give two examples of formal markets found in Zimbabwe.
..... [2]

SECTION B [30 Marks]

You are required to choose 3 questions from any **ONE** of the given options.

Option 1

General Agriculture

1 a) Explain the effects of population on land-use. ..... [5]
b) Suggest possible solutions to the effects of population growth. ..... [5]
2 Describe different farming systems in agriculture. ..... [10]
3 Describe ways of reducing effects of environmental factors on agricultural activities. ..... [10]
4 a) Name the most influential environmental factor influencing agriculture in Zimbabwe. ..... [1]
b) For the named environmental factor, discuss how the factor can be managed under extreme low and high conditions. ..... [9]

Option 2

Crop production

1. a) Differentiate monocotyledonous from dicotyledonous plants. ..... [4]
b) Draw and label the structures and parts of either a maize or a bean flower. ..... [6]
2. a) Differentiate between seed germination and emergence. ..... [3]
b) State advantages and disadvantages of asexual reproduction. ..... [4]
c) State the requirements for seed germination. ..... [3]
3. a) Explain factors to consider when selecting a site for an orchard. ..... [4]
b) Describe and illustrate how an orchard fruit tree is planted. ..... [6]
4. a) List the planting patterns that can be used when planting orchard trees. ..... [4]
b) Discuss the reasons for pruning fruit trees. ..... [6]

Option 3

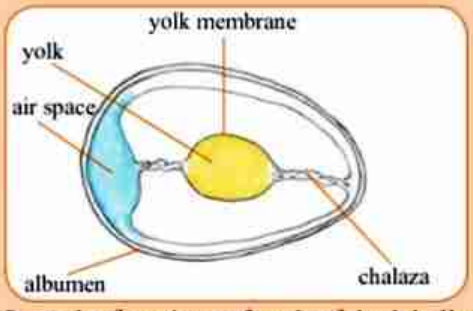
Forestry and wildlife

1. a) Describe factors influencing choice of a nursery site. ..... [5]
b) Discuss the management of a forest tree plantation. ..... [5]
2. Explain the sustainable methods that can be used when utilizing wildlife resources. ..... [10]
3. a) Give two specially protected plants and three protected animals in Zimbabwe. ..... [5]
b) Name any two problem animals found in Zimbabwe. ..... [2]
c) Suggest methods or ways of dealing with problem animals. ..... [3]
4. a) List the indigenous hardwoods found in Zimbabwe. ..... [3]
b) Name the important exotic softwoods grown in Zimbabwe. ..... [2]
c) Outline the major important steps followed when establishing a nursery. ..... [5]

Option 4

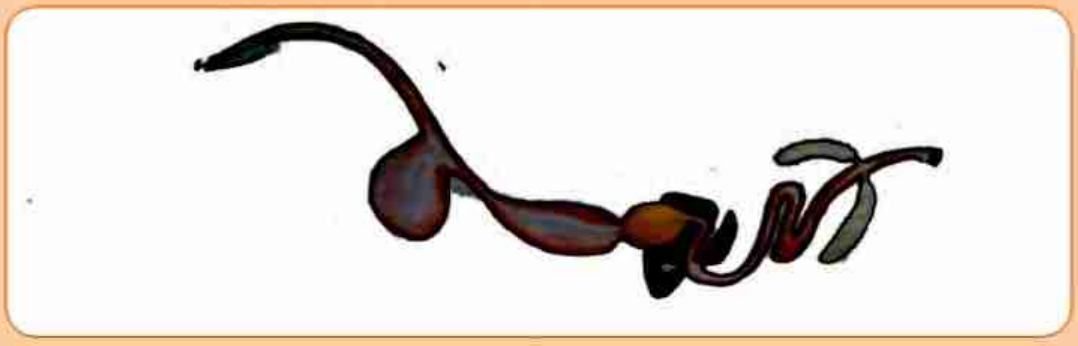
Livestock production

1. a) Give examples of two ruminant animals and two non-ruminant animals. ..... [4]
b) Draw and clearly label the digestive system of a ruminant animal. ..... [6]
2. a) With the aid of a diagram, describe the egg formation process in a hen. ..... [5]
b) Study the structure of an egg given below.



(i) State the functions of each of the labelled parts of the egg ..... [5]

3. Shown in the diagram is the digestive system of a farm livestock. Use the diagram to answer the following set of questions



a) Name the farm livestock likely to have such a digestive system. ..... [1]
b) Redraw and label all the parts on the digestive system. ..... [6]

4. a) What is the importance of hygienic practices in livestock production? ..... [2]
b) Discuss the methods that can be used by farmers to control livestock diseases. ..... [8]

Option 5

Farm structures and machinery

1. a) For either a cultivator or a mouldboard plough, discuss how one would carry out operating depth adjustments on the animal drawn implements. Include diagrams to explain the procedures. ..... [8]
b) Give the uses of a spike toothed harrow. ..... [2]

2. a) For a named type of fence, discuss its advantages and disadvantages ..... [2]
b) Identify the following tools and give their functions:

(i)  ..... [2]

(ii)  ..... [2]

(ii)  ..... [2]

3. a) Discuss the factors to be considered when siting the farm roads. ..... [5]
b) List the surveying equipment required when siting a farm road. ..... [5]

4. a) What is the difference between a breast band and a collar harness? ..... [2]
b) Describe the properties of materials used for making harnesses? ..... [3]
c) Draw and label the parts of a breast band. ..... [5]

Option 6

Agri-business management

1. a) What is the importance of agri-business management to agriculture? ..... [1]
   b) List possible farm expenditure items. ..... [4]
   c) What are the functions of a profit and loss account? ..... [5]
2. a) What activities are done to agricultural products before they are marketed? ..... [2]
   b) Distinguish between controlled and uncontrolled markets in Zimbabwe, siting examples. ..... [4]
   c) Describe the formal and informal markets for agricultural products in Zimbabwe. ..... [4]
3. a) Explain the benefits of agricultural cooperatives. ..... [5]
   b) What are the problems associated with agricultural cooperatives? ..... [5]
4. a) (i) Make calculations for income and expenditure for farm **A** and Farm **B**.

Farm A

Total income = $18500
Total expenditure = $ 4550
Calculate the profit $.....profit

Farm B

Total income = $1500
Total expenditure = $ 4550
Calculate the profit $.....profit ..... [4]
(ii) Which farm made a loss? ..... [1]

b) Complete the table below:

Sophia farm

Income/Returns		**Expenditure/Cost**	
Sell of cabbage heads @ $1 for 7:	$12500	Seed 5 x 25kg	$ 150
		Lime 50 x 50kg	$ 150
		Fertilizers – compound D	$ 10
		– ammonium nitrate	$ 100
		Transport (fertilizer and lime)	$ 100
		Herbicides	$ 30
		Pesticides	$ 40
		Tractor fuel 125 litres	$ 90
Subtotal			**$.....**
		Rentals	$ 1000
		Electricity bills	$2000
		Casual labour x 5	$3000
Total income	$1.....	Total expenditure	$.....
Difference $.....			

[5]

Index