MINISTRY OF EDUCATION

AGRICULTURE EDUCATORS AND TRAINERS ASSOCIATION OF GHANA

AETAG

Agricultural Science

for Senior High Schools

Year 2

Eric Amoah

Abdulai S. Gong

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FOREWORD

Ghana's new Senior High School Curriculum aims to ensure that all learners achieve their potential by equipping them with 21st Century skills, knowledge, character qualities and shared Ghanaian values. This will prepare learners to live a responsible adult life, progress to further studies and enter the world of work. This is the first time that Ghana has developed a Senior High School Curriculum which focuses on national values, attempting to educate a generation of Ghanaian youth who are proud of our country and can contribute effectively to its development.

The Ministry of Education is proud to have overseen the production of these Learner Materials which can be used in class and for self-study and revision. These materials have been developed through a partnership between the Ghana Education Service, teacher unions (Ghana National Association of Teachers- GNAT, National Association of Graduate Teacher -NAGRAT and the Coalition of Concerned Teachers- CCT) and National Subject Associations. These materials are informative and of high quality because they have been written by teachers for teachers with the expert backing of each subject association.

I believe that, if used appropriately, these materials will go a long way to transforming our Senior High Schools and developing Ghana so that we become a proud, prosperous and values-driven nation where our people are our greatest national asset.

Haruna Iddrisu MP

Minister for Education

SECTION

1

SCIENTIFIC EXPERIMENTAL PROCEDURE AND SAFETY IN AGRICULTURE

NEW DAWN IN AGRICULTURE

Misconceptions and Prospects in Agriculture and Farming

INTRODUCTION

You are welcome to year two. This first section in Agricultural Science will introduce you to the scientific experimental procedure and safety. Imagine growing crops that thrive, raising livestock that flourish and farms that prosper. How do farmers achieve this? Through systematic experimentation and precise measurement. In this section, you will discover:

1. The meaning and relevance of scientific experimental procedure in Agricultural Science.
2. Scientific experimental procedures in Agricultural Science
3. Measuring instruments used in agricultural production
4. Simple scientific measuring tools for assessing parameters in agricultural production.
5. Safety in operating farm machines in agricultural production.
6. First aid in agricultural production.

Get ready to uncover the science behind farming, cultivate curiosity and develop practical skills.

KEY IDEAS

- Farm machines: This refers to devices used to cultivate and prepare the soil, plant and harvest drops, irrigate and water crops, and handle and process agricultural produce.
- First aid: This refers to the first help or treatment given to someone who is injured or suddenly becomes sick before they can get professional medical help.
- Measuring instrument: This refers to a device used to quantify and record physical parameters such as temperature, humidity, soil moisture, pH levels and many others.
- Safety measures: This refers to procedures, protocols, and equipment designed to prevent or minimise accidents and injuries, damages to crops, livestock, and equipment, environmental hazards and health risks.
- Scientific experimental procedure: This refers to a step-by-step process used to test ideas or solve problems in a discipline.

THE MEANING AND RELEVANCE OF THE SCIENTIFIC EXPERIMENTAL PROCEDURE IN AGRICULTURAL SCIENCE

Definition of the Scientific Experimental Procedure

Scientific experimental procedure is a step-by-step process used to test ideas or solve problems in a discipline. It can also be defined as a set of procedures used to investigate research questions, test hypotheses, and draw relevant conclusions that clarify, explain, or provide an answer to the questions and hypotheses stated.

Relevance of the Experimental Procedure in Agricultural Science

The experimental procedure has some relevance in Agricultural Science, among which include:

1. Enhanced crop and livestock production: Scientific experiments produce relevant information that helps develop and optimise agricultural practices, including increasing crop yields, managing pests and diseases effectively, enhancing soil fertility, improving animal husbandry practices, and implementing successful livestock breeding programmes. For example, testing different fertilisers to increase maize yield.
2. Sustainable production: Through scientific research, long-term productivity is achieved by the development of efficient and sustainable farming methods. This lessens the use of chemicals on farms and encourages the conservation of resources, including water, soil, and energy. For instance, comparing organic and chemical farming practices.
3. Reduced negative environmental impact: Through scientific research, production systems that minimise negative environmental impact and help in the preservation of natural resources are developed. Among many other things, it helps to reduce soil degradation, water pollution, and biodiversity loss. For example, researching how composting affects soil health.
4. Food security: Scientific research helps improve food production systems, promoting global food security by ensuring a stable and sufficient food supply. This ensures increased food availability, better food quality, and lower post-harvest losses. For example, looking at ways to keep grains from spoiling.
5. Innovations and technological advancements: New agricultural technology, including genetically modified crops, enhanced irrigation systems, and precision farming instruments and techniques, is developed as a result of scientific experimentation. Drone testing for agricultural monitoring is one example.
6. Sound policy and decision-making: Policymakers develop well-informed regulations and policies related to agriculture, food safety, and environmental

protection based on trustworthy experimental evidence. Furthermore, experimental procedures turn policy decisions into evidence-based ones, and data-driven farming practices result in well-informed resource allocation on the farm. Analysing data on the effectiveness of fertiliser subsidies is one example.

7. Adaptation to climate change: Scientific experiments on the effects of climate change on agriculture, such as the effects of temperature on agricultural yields, help create climate-resilient crops, enhance drought-tolerant species, and adapt to changing climatic conditions.
8. Total character formation: Scientific research/experimentation encourages critical thinking, problem-solving, collaboration and teamwork, and digital literacy. Once more, it improves positive interpersonal relationships and enhances writing abilities. Writing research papers and reports helps people become more objective, fair and honest in their interactions. Conducting experiments fosters analytical thinking, creativity, and curiosity.

Activity 1.1: Scientific experimental procedure

Imagine you and your friend are agricultural researchers tasked to give a presentation to your classmates on the scientific experimental procedure. Design and make a presentation to the larger class. Your design may include:

1. A clear meaning of the scientific experimental procedure in Agricultural Science.
2. An outline of key components of the scientific experimental procedure in Agricultural Science in a flow chart.
3. Discussion on the relevance of scientific experimental procedure in Agricultural Science.

Follow the steps below to achieve Activity 1.1:

a. Form a group of three and discuss the meaning of scientific experimental procedure in Agricultural Science.

b. With your group, surf the Internet for information on the key components of the scientific experimental procedure in Agricultural Science and put your findings in a flow chart.

c. With the same group, search online for information on the relevance of the scientific experimental procedure in Agricultural Science. Discuss your findings and write them down.

d. Present your findings to the larger class.

SCIENTIFIC EXPERIMENTAL PROCEDURE IN AGRICULTURAL SCIENCE

In Agricultural Science, the scientific experimental process entails examining agricultural issues, putting theories to the test, and creating new methods or products. These processes aid in ensuring that results are valid, reliable, and applicable. The precise procedures to follow when performing scientific experiments are as follows:

1. Identify the research problem: Finding a study or research problem, or topic is the first step in doing a scientific experiment. To do this, you can carefully watch the plant, animal, or surroundings for things like how it looks, how much it produces, whether it has pests or diseases, or whether the soil is getting worse.
2. Decide the experimental treatments and variables:
    a. Treatments: These are the factors whose effects will be investigated.
    b. Variables: There are three types of variables: Independent, dependent and controlled.
        i. The independent variable (Treatment) is the factor that the experimenter or scientist can change (For example, type or rate of fertiliser).
        ii. The dependent variable is the factor that is tested to see how the treatment works (For example, leaf size or crop yield).
        iii. Controlled variable: Factors that are fixed by the researcher/experimenter or remain naturally constant, like water supply, sunlight, temperature, and soil type.
3. Design the experiment:
    a. Experimental plan: Describe the methods used, such as the field plan, treatments, materials, special tools, equipment and procedures.
    b. Include a control: A treatment that does not receive any level of the independent variable, like not getting any fertiliser. This makes it possible to see and measure the difference between an area that gets fertiliser and an area that does not get any fertiliser.
    c. Include a check: A treatment that is the recommended amount of the independent variable
        i. **Replication:** Repeat all treatments at least three times to ensure data reliability.
        ii. **Randomisation:** Randomly assign treatments to plots in the different replications to get rid of bias and confounding treatment effects as much as possible.
        iii. Assemble the materials you will need for the experiment, like seeds, fertilisers and measuring tools.
4. Prepare the experimental site: This could be in a school laboratory, a greenhouse, a field plot or a farmer's field.

5. Experimental layout: Set up the experiment according to the design or plan and apply treatments in the way that was described.
6. Data collection: Use proper methods to collect data in a planned way, and make sure that you record observations accurately.
7. Data interpretation (Results):
    a. Make a list of the results and look for trends or patterns. You can put data into tables, charts, or figures.
    b. Determine whether the results support/prove or refute/disprove the hypothesis.
    c. Compare the findings or results to other studies and theoretical expectations, or talk about the results in light of those expectations.
8. Conclude:
    a. State the most important findings you learnt from the study.
    b. Explain what the results mean for farming in the real world and give any advice to farmers or other stakeholders.
    c. Point out any limitations of the study and suggest areas where more research should be done.
9. Report findings: Write a detailed report about the experiment that includes everything about it:

    An introduction, a review of literature, the materials and methods, the results, a discussion, and a conclusion with recommendations.
10. Repetition: Do the experiment again in different places at the same time or in different seasons to make the results credible.

Example of an Agricultural Science Experimental Procedure

1. Research problem: How does using different types of mulch affect soil moisture retention and crop yield in tomato plants?
2. Design:
    a. Divide a field into plots and randomly assign different mulch treatments: organic, synthetic, and no mulch (control).
    b. Use multiple replicates for each treatment to ensure reliable data.
3. Data collection and analysis:
    a. Measure soil moisture levels periodically and the final tomato yields.
    b. Use a statistical test to compare the mean soil moisture and yield between treatments.
4. Result interpretation:

a. Determine if differences in soil moisture and yield between the treatments are significant.

b. Interpret the practical implications for farmers.

5. Reporting: Prepare a report detailing the methodology, results and recommendations, and present it to relevant stakeholders.

Activity 1.2: Stages involved in scientific experiments

In pairs, watch a video documentary of a scientific experiment on the Internet. Identify and discuss the stages involved in conducting scientific experiments in Agricultural Science with relevant examples

Follow the steps below to undertake **Activity 1.2:**

a. Search online for videos on "Stages involved in conducting scientific experiments".

b. Watch carefully and identify the steps involved in experimenting.

c. Discuss your findings with the larger class.

Project Work

Imagine you and your friends are agricultural researchers tasked with improving crop yields. Design an experiment to investigate the effect of different fertiliser rates on a chosen crop yield (e.g. maize yield, tomato yield). Write a report and present it to the larger class.

Follow the steps below to conduct the project work:

1. Pair up with a friend
2. Search for information on factors affecting maize or tomato yield and discuss them. For example, fertiliser type, fertiliser rate, variety of maize or tomato, soil pH, climate)
3. Select one factor (e.g. fertiliser rate)
4. State your research problem and formulate a hypothesis (e.g. which rate of fertiliser produces the best maize yield?)
5. Provide information on experimental design (independent variable (fertiliser rate), dependent variable (maize yield), any control variable (same amount of water), sample size, data collection methods)
6. Prepare your presentation report (Introduction, hypothesis, experimental design, expected outcomes, results, relevance to agricultural practices)

MEASURING INSTRUMENTS USED IN AGRICULTURAL PRODUCTION

Simple Scientific Measuring Instruments for Assessing Parameters in Agricultural Production.

1. In agricultural production, different measuring instruments/tools are used to assess different aspects of farming production. These tools help farmers and researchers collect data for decision-making and improve the way they farm. These are some scientific measuring tools commonly used in agriculture:
2. Soil pH meter: This is used to find out how acidic or alkaline the soil is. Finding the pH of the soil is very important for determining how fertile it is and how many nutrients plants can get from it.
    a. Chlorophyll meter: Chlorophyll meters measure the amount of chlorophyll in plant leaves and look for signs of stress. This helps with managing nutrients and plant health and predicting crop yields.
    b. Nitrogen management: Chlorophyll meters check how much nitrogen plants have. Nitrogen is an important part of chlorophyll. Its deficiency or excess can be detected through changes in chlorophyll content.
    c. Fertiliser optimisation: Chlorophyll meters help farmers get the most out of their fertiliser applications by giving them real-time information on the nitrogen levels of plants. This saves them money and has fewer bad effects on the environment.
3. Soil tensiometer: A soil tensiometer is an instrument used to find out the soil water tension, which tells you how wet the soil is and how much water plants can get. This tool is essential for managing irrigation well and knowing how soil, water, and plants work together.
4. Nitrate test strips: Nitrate test strips are simple and effective tools used to measure the concentration of nitrate ions (NO_3^-) in water, soil, and plant tissues.
5. Weighing scales (balances): They are very important tools in agriculture for figuring out how much something weighs in grammes (g), kilogrammes (Kg) or pounds (lbs). Weighing scales are commonly used in agriculture to:
    a. Weigh harvested crops to determine yield.
    b. Monitor the weight of livestock for checking their health, breeding and sale.
    c. Measure the weight of feed to ensure proper nutrition for animals.

Figure 1.1: Scientific Measuring Instruments for Assessing Parameters in Agricultural Production.

6. Vernier callipers: Vernier callipers are precision measuring instruments that allow you to find linear dimensions, depths and diameters. The primary graduation is in millimetres, but some callipers also have markings in centimetres for reference.
7. Soil thermometer: A soil thermometer is a tool used to measure the temperature of soils at varying depths. The temperature of the soil is very important for farming and gardening because it affects how quickly seeds germinate, how fast plants grow, how active microbes are, and how many nutrients are available.
8. Rain gauge: A rain gauge is an instrument used to record the amount of rainfall over a specific period at a particular location. Crop growth is directly related to the millimetres (mm) of rain that falls in a certain place.
9. Leaf area metre: This is an instrument used to measure the surface area of leaves. It helps in tracking the growth and development of plants by providing precise measurements of leaf area, which is a key factor in studying plant growth. Leaf area is a significant predictor or indicator of crop yield. Farmers and agronomists use leaf area data to estimate how much a crop might produce and to make smart choices about how to use resources. Monitoring changes in leaf area can help detect diseases and pest infestations early, so that steps can be taken right away.
10. Anemometer: This device measures wind speed and direction, which are important factors for pesticide and liquid fertiliser application, to reduce drifts, particularly to unwanted areas.

Figure 1.2: Scientific Measuring Instruments for Assessing Parameters in Agricultural Production

11. Air thermometer: Temperature readings from air thermometers are very important in agriculture because they are used for many things related to managing crops, taking care of animals and running the farm. Temperature is measured in either Fahrenheit (^{0}F) or Celsius (^{0}C).

Agricultural Applications of Thermometers

1. Timing of planting: Temperature data helps farmers figure out the best time to plant, particularly in temperate and hot, dry zones. Certain crops require specific temperature ranges for germination and early growth.
2. Micro-climate control: In greenhouses, plants need to be at the right temperature to be healthy and productive. Thermometers help monitor and regulate the internal climate, making sure it stays within desired ranges.
3. Disease prevention: Proper temperature regulation in enclosed environments such as silos, warehouses and cold rooms, can prevent the spread of pests and diseases, which often thrive in specific temperature conditions.
4. Health monitoring: Special thermometers are used to monitor the body temperature of livestock and humans, helping detect illnesses early. Abnormal temperatures can be a sign of illnesses or other health problems.
5. Syringes: Farmers and veterinarians use syringes to give animals medicines, vaccines and other substances that keep them healthy.
6. Soil moisture meter: This device checks the moisture content of soils, thus helping to optimise irrigation scheduling and prevent overwatering or underwatering.
7. Measuring tape: Measuring tapes are used to determine distances such as field dimensions, plot sizes, and plant spacing. They are graduated in metric units (millimetres) and imperial units (inches).
8. Drenching guns: Drenching guns are special devices used to give animals medicine by mouth. The guns are designed for livestock such as cattle and small ruminants.
9. Measuring cylinders: These are used to measure liquid volumes accurately. They are calibrated to measure liquid volumes precisely, with markings typically in millilitres (ml) or litres (L).

Figure 1.3: Scientific Measuring Instruments for Assessing Parameters in Agricultural Production

10. Beakers: These are used in the lab to measure liquids. Beakers have volume markings on them that let you measure approximate volumes of liquids for scientific experiments. Most beakers, especially those used in scientific and educational laboratories, have graduations in millilitres (ml). This unit is suitable for measuring small to moderate volumes of liquid.

11. Light meter: This detects light intensity, hence suitable for assessing light levels for crop growth and determining shade requirements. An example is the portable digital light meter used to measure illuminance in lux units.

Precautions when using measuring tools to ensure accurate measurements.

1. Calibrate instruments: Regularly calibrate measuring tools to ensure accuracy.
2. Use appropriate instruments: Select the right tool for the specific measurement task.
3. Follow manufacturer's instructions: Read and follow the manufacturer's guidelines for using the measuring tool.
4. Record measurements accurately: Record measurements accurately and legibly to ensure reliable data.
5. Take multiple readings: Repeat measurements to ensure accuracy and consistency.
6. Clean and maintain instruments: Regularly maintain measuring tools to ensure accuracy and longevity.
7. Be aware of environmental factors: Consider factors such as temperature and humidity that may affect particular measurements.
8. Use appropriate units: Use the appropriate units for the parameters, such as inches, feet, or meters for length, and pounds or kilograms for weight.
9. Use protective gear: Wear protective gear, such as gloves and safety glasses, when taking certain measurements in agricultural settings.
10. Avoid errors: Ensure that the instrument is viewed face-on and not from the side.

Activity 1.3: Agricultural measuring tools

In pairs, list at least ten agricultural measuring tools and discuss their respective uses. Make a presentation to the class.

Activity 1.4: Precautionary measures to ensure accurate measurements

Find a friend and discuss the necessary precautionary measures that ensure accurate measurements when using the measuring tools, and present your findings to the class.

SIMPLE SCIENTIFIC MEASURING TOOLS FOR ASSESSING PARAMETERS IN AGRICULTURAL PRODUCTION

Basic Parameters Measured in Agricultural Production and Their Calculations

For agricultural production, productivity, efficiency, and quality are assessed by several parameters or factors. These parameters or factors can vary depending on the crop, livestock, or farming method. Here are some basic parameters that are often measured in agriculture, along with brief explanations of how they are calculated:

Basic Parameter	Description
Temperature	Temperature is measured in degrees Celsius (°C) or Fahrenheit (°F) using thermometers. Use a thermometer that is made for that job (for example, a rectal thermometer for animals). To get an accurate reading of body temperature, place the thermometer in the appropriate location (like the rectum or mouth) and wait for the reading to stabilise. Other parameters are air temperature and soil temperature.
Relative humidity	This is the ratio of the amount of water vapour in the air to the maximum the air can hold at a given temperature. Relative humidity is measured with a hygrometer or a digital humidity meter. The device is hung in the desired area or environment to obtain the readings.
Area of a vegetable bed	This, in simple terms, is how big a vegetable bed is. To find out, multiply the length by the width of the bed using a measuring tape or distance measuring wheel. **Formula**: Area = Length x Width
Plant height	This is how tall a plant is. Measuring tapes are used to determine plant height in centimetres or inches. This is done regularly to see how the height changes.
Growth and development	Growth is the increase in height, girth, spread and weight. Development, on the other hand, means a change in complexity due to the addition of new tissues and structures. Plant growth is assessed by determining the fresh or dry weight regularly. The plant parts are weighed and dried with scales and ovens. The oven temperature is kept between 400 and 700C during the drying process. Where destructive sampling cannot be done, standard growth stage scales for specific crops are used to estimate growth.

Plant population density	To find this, divide the total area to plant by the product of the inter-row and intra-row spacing, then multiply by the number of plants per stand/hill. Usually, plant population density is determined on a per hectare basis, i.e. an area of 100 m by 100 m area. **Formula:** 10,000 m^2/x*y where x = inter-row spacing (m) and y = intra-row spacing (m).
Yield	This refers to the amount of agricultural produce (e.g., crops, livestock) harvested per unit area. Crop yield is typically measured in kilograms/hectare (Kg/ha) or pounds/acre and indicates the prod uctivity of the farming system. For measuring yield, you need a measuring tape to find out how big the land is and a scale to find out how much the food weighs. Usually, the area harvested is less than one hectare or one acre, hence, the yield is extrapolated to one hectare. Yield is also measured in megagrams per hectare (Mg/ha), formerly designated as tons/ha.**Calculation:** Crop yield/hectare = $\frac{\text{Quantity of product harvested (Kg)}}{\text{Unit of land area (m2)}}$ x 10,000 (m2)
Hen day egg production	For hen day egg production, count the number of eggs a group of hens lay in a specific period, like 24 hours. Then divide the total number of eggs by the number of birds to get the hen day egg production. The unit of measurement then becomes **y** eggs/ hen/day. Where fractions occur, the value is rounded to the nearest whole number.
Feed conversion efficiency (FCE)	This measures the amount of feed that animals eat (feed intake). Measure the weight gain of the animals over a specific period. To find the feed conversion rate, divide the amount of feed eaten by the amount of weight gained.
Heart rate	Find the animal's pulse point. For big animals, this could be done by pressing on the femoral artery located at the top of the thigh of the animal. For smaller animals, this could be done by feeling the heartbeat through the chest. To find the heart rate, count how many times your heart beats in a certain amount of time, like one minute. In the case of humans, you can detect the pulse on the wrist or the anterior side of the ear of your colleagues.
Mortality rate	Count the total number of deaths in a starting population of the animal or crop within a specific period. Divide the number of deaths by the starting population and multiply by 100 to determine the mortality rate as a percentage.
Dressing percentage of the carcass	First, measure the live weight of the animal and then weigh its dressed carcass (after removing feathers, internal organs, blood and skin). To determine the dressing percentage, divide the dressed carcass weight by the live weight and multiply by 100.

Stocking rate (Fingerlings)	This depends on the tank's volume. Number of fingerlings to stock = (Pond volume (m^3) x Stocking density (fish/m^3) / Average weight the fish are expected to grow to.
Stocking rate (Ruminants)	This depends on the land area available. To find the stocking rate, divide the total area by the recommended area per animal (based on species and desired stocking density) and multiply the result by 100.
Soil nutrients	This includes nitrogen (N), phosphorus (P), potassium (K) and other essential nutrients like calcium and magnesium. Soil nutrient levels are determined by using soil testing kits and nutrient analysis instruments.
Soil pH	pH (potential of hydrogen) is a measure of the acidity or alkalinity of a solution or substance. The pH scale ranges from 0 to 14. pH 7 is neutral, below 7 is acidic and above 7 is alkaline. pH can be measured using pH meters, soil test kits, litmus paper or pH indicator solutions.
Soil moisture	Soil moisture is measured as the percentage of water content using soil moisture meters or sensors. In agricultural and environmental sciences, knowing how much water is in the soil is important for understanding plant water availability, soil health and how to manage irrigation.
Pest and disease assessment	This includes the presence and severity of pests (such as insects, weeds, pathogens) and diseases. Measurement is done by visual observation, pest traps, and disease assessment or scoring based on symptoms.
Water quality	The quality of the water is assessed by its pH, electrical conductivity (EC), dissolved oxygen (DO), and nutrient levels.
Weather conditions	On weather conditions, precipitation (dew, rain and snow), humidity, wind speed, and solar radiation are some of the factors or parameters that are considered. Weather data is collected using weather stations equipped with sensors for measuring these parameters. Tools used include a rain gauge for rainfall, a thermometer for air temperature, a hygrometer for measuring humidity, a barometer for atmospheric pressure and an anemometer for wind speed. Others include a wind vane for measuring wind direction and a pyranometer for solar radiation (incoming solar energy).

Agri-input use	The most important part of food production is the use of agri-inputs, especially fertilisers and chemicals. The essential aspects to think about are the amount and timing of the input applications. Fertiliser amounts are based on recommended rates and are weighed with electronic scales or calibrated scoops, while pesticide amounts and rates are determined with either pipettes, measuring cylinders or graduated caps.
Quality parameters	These assess attributes of agricultural produce such as appearance, amount of debris, size, taste and nutritional content. For fruits and vegetables, quality depends on sugar content (% Brix), acidity (pH), moisture content and colour.
Efficiency parameters	These measure how effective resources like water, fertiliser or energy are used in agricultural production. For example, water use efficiency (WUE) calculates the amount of crop produced per unit of water used. Fertiliser use efficiency measures crop yield per unit of fertiliser applied.
Costs and returns	These depend on the costs incurred and benefits generated from agricultural production. For example, the total cost of production includes expenses for inputs like seeds, fertilisers, pesticides, labour and machinery. Returns are the revenue or money you generate from selling agricultural products. Profitability is often assessed by comparing returns to costs.
Environmental impact	The effects of agricultural production on the environment such as poor air quality, greenhouse gas emissions, surface and groundwater contamination and pollution, and soil pollution and erosion. Environmental impact parameters vary widely and require specific methodologies or models to quantify accurately.

Experiment 1.1: Determining the moisture content of a soil using the oven-drying method

Materials Needed

- Soil sample
- Weighing balance
- Moisture cans (metal containers)
- Oven (capable of maintaining 105-110°C)
- Desiccator
- Tongs or gloves (to handle hot containers)

Note: It would be best to carry out this experiment in the wet season or by taking a sample from an irrigated field.

Procedure

1. **Sample collection**: Collect a representative soil sample from the field using an auger or an earth chisel. Reach at least 15 cm below ground level. Collect several samples from different parts of the field and combine them before taking subsamples. Ensure the sample is stored in an airtight container to prevent moisture loss.
2. **Weighing the soil sample**:
   a. Clean and dry a moisture can.
   b. Weigh the empty moisture can using the weighing balance and record its mass (W_1).
   c. Place a sample of the soil in the moisture can. Typically, 20-30 g of soil.
   d. Weigh the moisture can with the soil and record its mass (W_2).
3. **Drying the soil sample**:
   a. Place the moisture can with the soil sample into the oven.
   b. Dry the sample at a constant temperature of 105-110°C for 24 hours. This temperature is chosen to remove moisture without damaging the composition of the soil.
4. **Cooling the sample**:
   a. After drying, remove the can from the oven using tongs or gloves.
   b. Place the can in a desiccator to cool to room temperature. This prevents the absorption of moisture from the air during cooling.
5. **Weighing the dry sample**: When cool, weigh the can with the dried soil and record its mass (W3).
6. **Calculation**:
   a. Determine the Mass of Water: $W_{water} = W2 - W3$
   b. Determine the Mass of Dry Soil: $W_{dry\ soil} = W3 - W1$
   c. Calculate the Moisture Content: $\text{Moisture Content} = (\quad) \times 100$

Worked Example

Assume the following recorded masses:

Mass of empty can (W_1) = 40 grams

Mass of can + wet soil (W_2) = 90 grams

Mass of can + dry soil (W_3) = 70 grams

1. Mass of water (W_{water}) = 90 – 70 =20 grams

2. Mass of dry soil ($W_{dry\ soil}$) = 70 – 40 = 30 grams
3. Moisture content (%) =$(\frac{20}{30})$ x 100 = 66.67%

Note:

- Ensure the oven temperature is accurate and consistent.
- Ensure accurate weighing and drying procedures to obtain reliable results.
- Handle all samples with care to avoid contamination and moisture loss.
- Repeat the experiment with multiple samples to account for variability and ensure representative data for more accurate results.

7. **Interpretation and application of results**:
   a. Compare moisture content values among soil samples or depths to understand variability.
   b. Use the results to assess soil water availability, determine irrigation needs, or evaluate soil health.

Activity 1.5: Measurement of some basic parameters

In pairs, use available instruments in your school laboratory/locality to measure some selected parameters. Record and take note of variations in your measurements and observations. Discuss your findings with other classmates.

Activity 1.6: Scientific measuring tools and instruments

In pairs, search online and watch videos/pictures on appropriate uses of the scientific measuring tools and instruments unavailable in your school laboratory and discuss your observations with other friends.

SAFETY IN OPERATING FARM MACHINES IN AGRICULTURAL PRODUCTION

This focal area equips you with essential knowledge and skills on safety in operating farm machines in agricultural production, and the importance of observing safety measures when operating farm machines and power tools.

Safety Measures Employed in Operating Farm Machines and Power Tools

It is very important to know how to use farm machines safely to avoid accidents and injuries. Here are some of the things that should be done to stay safe when using farm machines and power tools:

1. **Training and education**
    a. Ensure all operators receive comprehensive training on how to use each machine.
    b. It is important to read and understand the operator's manual for each piece of equipment.
2. **Pre-operation inspection routines**
    a. Inspect machines before you use them to ensure that they are in good working condition.
    b. Verify that oil, fuel and other fluid levels are adequate before you start the engine.
    c. Check the tyre pressure and the condition of the brakes before you move the machine.
    d. Keep a first aid kit accessible and make sure you have emergency contact numbers readily available.
3. **Use of personal protective equipment (PPE)**
    a. Wear clothes that fit closely so you do not get caught in the machines' moving parts.
    b. Wear protective gear such as gloves, safety glasses, earbuds and boots when operating farm machines.
4. **Proper behavioural practices**
    a. Do not use mobile phones or other distractions while operating machinery.
    b. Take regular breaks to avoid fatigue and prevent accidents.
    c. Do not operate machinery under the influence of drugs or alcohol.
5. **Safe operational practices**
    a. Ensure the work area is free of obstructions and hazards before operating machines.
    b. Keep bystanders, especially children, away from running machines and equipment.
    c. Avoid operating on steep slopes or uneven terrain to prevent rollovers.
    d. Turn off the engine before performing any maintenance or adjustments.

6. **Machine-specific safety measures**
    a. Use rollover protective structures (ROPS) and seat belts when operating farm machines.
    b. Stay clear of moving parts of combine harvesters and keep shields in place when using them.
    c. Do not attempt to clear blockages while fodder balers are running.
    d. Keep power take-off (PTO)shields in place and avoid loose clothing that can get caught on the tractor.
7. **Proper environmental considerations**
    a. Ensure adequate lighting for operations early in the morning or late in the evening.
    b. Avoid operating machinery during adverse weather conditions like heavy rainfall.
8. **Technology and innovations**
    a. Use machines equipped with safety sensors and automatic shut-off systems.
    b. Employ GPS and automated systems to reduce human error and enhance precision.
9. **Regular maintenance and repairs**
    a. Perform regular maintenance according to the manufacturer's recommendations.
    b. Ensure repairs are conducted by qualified personnel.
    c. Use lockout/tagout procedures to ensure machines are not started accidentally during maintenance.
10. **Safe handling of chemicals and fuels**
    a. Store chemicals and fuels in the appropriate, clearly labelled containers and away from ignition sources.
    b. Use proper procedures to handle spills and leaks to prevent accidents and environmental contamination.

Importance of Observing Safety Measures When Operating Farm Machines and Power Tools

1. Safety measures like proper training, use of PPE and adherence to safety protocols help to prevent accidents.
2. Proper training and safety measures ensure that workers can respond effectively to emergencies, reducing the potential impact of accidents.
3. Implementing safety measures reduces the liability of farm owners and operators in the event of an accident.

4. Proper maintenance and safety checks ensure that machines function correctly, reducing the likelihood of accidents due to mechanical failures.
5. Preventing accidents reduces medical expenses and costs associated with workers' compensation.
6. Complying with safety regulations minimizes legal action and associated costs due to workplace accidents.
7. Regular maintenance and safety checks prolong the lifespan of machinery and ensure efficient operation.
8. A safe working environment boosts worker confidence and morale, leading to higher productivity and better job satisfaction.
9. Utilising advanced safety features like sensors, GPS and automated systems enhances precision and safety, keeping the farm competitive.

Examples of Safety Gear for field work.

Protective overall

Goggles for protecting the eyes

Rubber hand gloves

Head-protecting helmet

Local straw hat for working in the sun

Man wearing full protective gear while spraying pesticide

Wellington boots for working in the field

Nose shield for pesticide application

Figure 1.4: Examples of Safety Gear for field work.

Activity 1.7: Correct usage of personal protective equipment

Find a friend and watch videos demonstrating the correct usage of personal protective equipment (PPE) in agricultural production and share your findings with other classmates.

Activity 1.8: Importance of observing safety measures

In pairs, discuss the importance of observing safety measures during selected farm activities or operating farm machines and make presentations to the class.

FIRST AID IN AGRICULTURAL PRODUCTION

Meaning of First Aid and the Contents of the First Aid Box

First aid is the first help or treatment given to someone who is injured or suddenly becomes sick before they can get professional medical help. It is the care that is given right away to save lives, keep conditions from getting worse, and help people get better. Cardio-pulmonary resuscitation (CPR), bandaging cuts and wounds to stop blood loss, treating burns with ointment, managing fractures, and giving medicines for severe allergic reactions (anaphylaxis) are all examples of first aid techniques and processes. A basic understanding of first aid is important for everyone, no matter what they do for a living, so they can help others in an emergency and save lives.

Key aspects of first aid

Key aspects of first aid include;

1. Recognition: Quickly identifying what kind of injury or illness it is and how bad it is.
2. Intervention: Giving the person the right care based on training and information to keep their condition stable.
3. Assessment: Monitoring the person's vital signs and responding to any changes you see.
4. Transportation: Making plans for more medical help and transportation to a healthcare facility if needed.
5. Support: Offering reassurance and emotional support to the person and those around them.

Some Contents (What is in) of First Aid Box/Kit and their Uses

6. Adhesive bandages: These are used to cover up small cuts, scrapes, or minor wounds. They keep dirt and germs away from the wound and help it heal.
7. Sterile gauze pads: Gauze pads are used for cleaning and covering larger wounds or cuts. They are sterile and absorbent, helping to control bleeding and prevent infection.
8. Adhesive tape: Adhesive tapes secure dressings or bandages in place. They provide support and help keep the dressing clean and intact.
9. Antiseptic solution or wipes: These are used to clean the skin around wounds or cuts, reducing the risk of infection. Common antiseptics include alcohol-based solutions or antiseptic wipes.

10. Disposable gloves: When giving first aid, you need to wear gloves to protect your hands. They help prevent the spread of germs, protect the caregiver and maintain a sterile/clean environment.

11. Pair of scissors: A pair of scissors with rounded edges is included to cut tape, gauze, or clothing when necessary. They are useful for removing clothing from an injured area or cutting bandages to the desired size.

12. Tweezers: Tweezers are used to remove small splinters, foreign objects, or debris from wounds. They give you a good grip and help maintain cleanliness.

13. CPR mask or face shield: These devices are used when performing cardiopulmonary resuscitation (CPR) to provide a barrier between the rescuer and the victim. They prevent the transmission of infections and infectious diseases.

14. Instant cold packs: Cold packs help reduce swelling, inflammation and pain associated with injuries. They are activated by squeezing or shaking and provide immediate soothing.

15. Pain relievers: Non-prescription pain relievers, such as acetaminophen or ibuprofen, are usually included in the kit for temporary relief from minor aches, pains, or fever.

16. Emergency contact information: It's important to have a list of emergency phone numbers, including local medical facilities, poison control centres and emergency services. This information ensures quick access to appropriate help during an emergency.

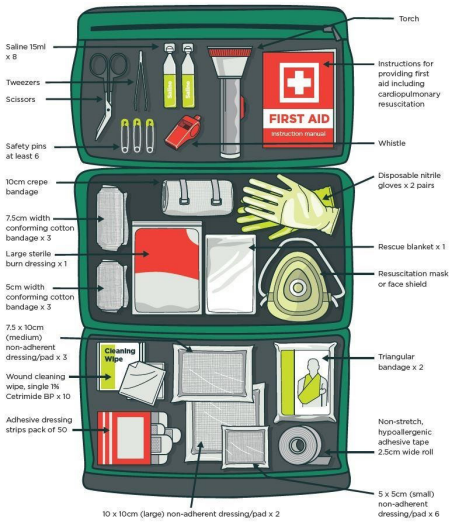


Figure 1.5: Some items found in a first aid box.

Procedure for Applying First Aid

The goal of first aid is to keep an injured person stable until medical help arrives. The exact steps for first aid will depend on the type of injury, but here are some common ones:

1. Ensure the injured person has an open airway (trachea) and is breathing.
2. Control bleeding by applying direct pressure to the wound with a clean cloth or bandage.
3. Immobilise any suspected fractures or spinal injuries by keeping the injured person still with appropriate immobilisation techniques.
4. Assess the situation to ensure safety and identify potential hazards to prevent further harm to the first aid provider and others involved.
5. **Call for help:** If the injury is severe or life-threatening, immediately call for emergency medical assistance or instruct someone to do so. Provide accurate details about the location, nature of the injury and other relevant information.
6. **CPR administration:** Administer CPR (cardiopulmonary resuscitation) if necessary and if trained.
7. **Stay calm and provide assurance and comfort:** Reassure the injured worker and try to keep the victim calm. Offer comfort and support while awaiting medical help. Keep the victim warm and provide reassurance that help is on the way.
8. **Document and report:** It is important to document the incident, including details of the injury, the first aid provided and any witnesses. Report the incident to the appropriate authority within your organisation or follow the established reporting procedures.

Implications of Using Inappropriate First Aid Materials and Treatments

1. Prolonged pain and discomfort: Using inappropriate materials or chemicals can cause unnecessary pain and discomfort to the victim.
2. Increased risk of infection: Using non-sterile materials or applying chemicals not intended for the purpose can increase the risk of infection.
3. Delayed or inadequate wound healing: Using inappropriate first aid materials, such as non-sterile or dirty bandages, can introduce bacteria or contaminants to the wound, leading to infection and delaying the healing process.
4. Allergic reactions: Some individuals may be allergic or sensitive to certain materials or chemicals, like adhesive bandages or antibiotics. Using inappropriate first aid materials or chemicals on wounds can trigger allergic reactions, ranging from mild skin irritation to severe allergic responses such as swelling, itching, or difficulty breathing.
5. Tissue damage and scarring: Improper application of chemicals on wounds, especially caustic or corrosive chemicals, can cause damage to tissue and subsequent scarring.

Indigenous Ways of Providing First Aid to Injured Persons at a Farm Site

1. Medicinal plants and herbs: Many indigenous communities exploit local plants and their medicinal properties. Traditional healers and some community members use specific herbs, leaves, or roots to create poultices, infusions, or ointments to treat wounds, reduce inflammation and ease pain.
2. Traditional bandaging techniques: Some indigenous communities have their own special ways of bandaging wounds. This includes using natural fibres like leaves or tree bark, to create bandages or splints to immobilise injured limbs.
3. Heat and cold therapies: Indigenous practices sometimes utilise heat or cold therapies to manage pain and inflammation. For example, applying hot or cold natural substances, such as heated stones or blocks of ice, to the injured area for relief and to reduce swelling.
4. Spiritual and cultural beliefs: Spiritual and cultural beliefs are often a part of indigenous first aid practices. Ceremonies, prayers, or rituals may be performed alongside physical treatments to provide emotional support, invoke healing, or seek guidance from ancestral spirits or deities/gods.
5. Traditional bone setting: Some cultures or societies have specialised individuals known as “bone healers” or “traditional bone setters” with unique knowledge and skills in setting fractures and dislocations.

Activity 1.9: Contents of a first-aid box

In pairs, identify and discuss the contents of a first aid box and their respective uses.

Activity 1.10: Indigenous ways of providing first aid

Find a friend and discuss the indigenous ways of providing first aid to at least five named injuries (For instance, burns, dislocations, sprains, cuts) in your community.

REVIEW QUESTIONS

1. Examine the relevance of scientific experimental procedures in Agricultural Science.
2. Explain experimental design in scientific experiments.
3. Outline the main uses of thermometers, anemometers, rain gauges and Vernier callipers in agricultural production.
4. Discuss four precautions that ensure accuracy when using agricultural measuring tools.
5. Explain the importance of determining the pH of a soil.
6. A soil sample weighs 200g when moist and 150g when oven-dried. Determine the percentage moisture content of this soil.
7. Demonstrate how PPE should be put on correctly before commencing a pesticide spraying exercise.
8. Discuss the importance of observing safety measures in operating farm machines.
9. Discuss at least three implications of using inappropriate first aid materials in treating wounds.
10. Prepare a table showing five injuries that can occur on a farm with the corresponding first aid in each case.

SECTION

2 ARABLE CROP PRODUCTION

NEW DAWN IN AGRICULTURE

Misconceptions and Prospects in Agriculture and Farming

INTRODUCTION

The production of arable crops is an important component in the agricultural sector in Ghana. The section discusses the dynamics of arable crop farming. You will learn about the principles and practices that support the cultivation of arable crops, including cereals, legumes and tubers. You are expected to demonstrate detailed knowledge of the meaning and examples of arable crops and progress to factors and processes that influence successful arable crop production. This section will also enable you to explore (discuss in detail) the economic importance of selected arable crops in the livelihood of the producers and the nation. Start-up packages, characteristics and patterns of growth of arable crop enterprises are also covered in this section.

KEY IDEAS

- **Arable Crops:** Herbaceous plants that can be grown in a season.
- **Cereal Crops:** Crops from the grass family which are grown for their grains.
- **Economic Importance:** This refers to the positive and negative effects of something.
- **Leguminous crops:** Crops with nodules on their roots that contain nitrogen-fixing bacteria (Rhizobium).
- **Roots and Tubers:** These are crops with edible roots or tubers.
- **Start-up packages** are the valuable resources new farmers seek and assemble to establish profitable and sustainable agricultural ventures.

INTRODUCTION TO ARABLE CROP PRODUCTION

Arable crops are normally grown in Ghana due to their usefulness. They are mostly grown to be used to prepare staple foods for most ethnic groups. For example, Dagomba's use maize to prepare Tuo Zaafi (TZ), Frafra's use millet or guinea corn to prepare TZ, Ashanti's use Cassava or Yam to prepare fufu, Ga's and Fanti's also use maize to prepare Kenkey.

Meaning and Examples of Arable Crops

These crops grow best in well-drained soils and are typically used for human consumption or animal feed. They are usually annuals that are grown again every year and are rotated to maintain soil fertility and control pests and diseases. For them to grow, the soil needs to be rich in nutrients and be able to handle ploughing and harvesting machinery. The climate also needs to be favourable. Here are some examples of arable crops:

Table 2.1: Examples of Arable Crops

Cereals	Root and tubers	Legumes
Maize	Cassava	Cowpea
Rice	Yam	Groundnut
Millet	Potato	Soybeans
Sorghum	Sweet potato	Bambara groundnut
Wheat	Cocoyam	Common beans
oats	Taro	Pigeon pea

Examples of Cereals

Maize

Rice

Wheat

Sorghum

Millet

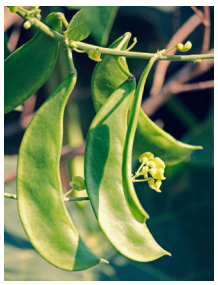
Figure 2.1: Examples of cereals.

Examples of Legumes

Cowpea

Soya beans

Bambara groundnut



Lima beans

Groundnut

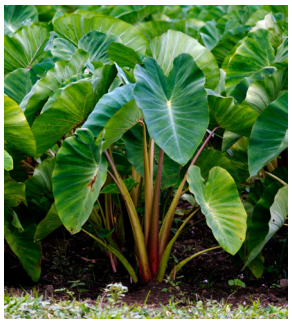
Pigeon pea

Figure 2.2: Examples of legumes.

Examples of Roots and Tubers

Sweet potato

Taro



Cocoyam

Irish potato

Cassava

Yam

Figure 2.3: Examples of Roots and Tubers

FACTORS AND PROCESSES THAT INFLUENCE SUCCESSFUL ARABLE CROP PRODUCTION

1. Adequate climate and weather conditions: For arable crops to grow and develop, the climate and weather conditions play important roles. The intensity and duration of the weather factors, such as rainfall, sunshine, and humidity, are very important for the various physiological processes they affect. For example, rainfall supplies plants with water, which helps in plant growth and development.
2. Seed quality and germination ability: It is important to have high-quality seeds that are free from scars, debris, diseases and pathogens, and have high germination rates. For arable crop enterprises to be successful, they need to grow crop varieties that do well in their locality and are resistant to pests and diseases.
3. Sustainable practices: To maintain the structure of the soil and reduce erosion, farmers should use sustainable agricultural practices like crop rotation, cover cropping, and conservation tillage.
4. Proper post-harvest handling: For arable crop enterprises to get the most out of their crops, post-harvest handling, such as cleaning, grading, packaging of produce, and proper storage facilities, should be put in place to prevent spoilage and maintain quality.
5. Soil quality: To grow arable crops successfully, the soils need to have adequate nutrients, good structure, favourable pH (pH 6-7) and good organic matter content.
6. Water management: To make sure crops get the right amount of water, it is important to consider efficient irrigation systems such as drip or sprinkler irrigation. For successful arable crop production, proper drainage prevents waterlogging and root diseases.
7. Crop management practices: To be successful in arable crop production, farmers should consider:
    a. Proper planting depth and spacing to optimise growth. Plant population is crucial to yield. If crops fail to germinate well, it affects the yield negatively, hence, proper plant spacing is important for good yield.
    b. Timely and effective weed control to prevent competition for nutrients, water and sunlight. Weed control should be carried out timely and appropriate manner to avoid competing with crops for resources like water, light, nutrients and space.
    c. Monitoring and integrated pest management (IPM) strategies to control pests and diseases. The effects of pests and diseases can affect crop yield. Therefore, there is a need to monitor your crops well and develop measures to prevent your crops from pest and disease attacks.
8. Nutrient management: To ensure successful arable crop production, it is important to apply adequate fertilisers at the right time, based on soil testing. Farmers should think about using compost, farmyard manure, and green manure to improve soil health.

9. Technology and mechanisation: To make arable crop production more efficient, modern machinery is needed for land preparation, planting, weeding and harvesting. Technologies like GPS and drones help farmers put in the right amount of fertiliser and monitor crop health.
10. Economic factors: Input availability and affordability are as important as markets to sell the produce at a profitable price. If inputs are easy to get and affordable, production costs go down, thus increasing profit for the farmer.

Economic Importance of Selected Arable Crops in the Livelihood of the Producers and the Nation

The economic importance of arable crops is vast and multifaceted, affecting the livelihoods of individual producers and the broader national economy. It is as follows:

1. Livelihood of producers
    a. Employment creation: The cultivation, harvesting, processing and transportation of arable crops create a lot of jobs in rural areas.
    b. Income generation: For many farmers, arable crops are their main source of income. Farmers get money from selling crops like maize, millet, cowpea, soya beans and yam at both local and international markets.
    c. Food security and nutrition: Many arable crops like rice, maize, and cassava are staple foods that make sure farming households in Ghana are food secure.
    d. Market diversification: Farmers can grow a lot of different crops to make their income more stable and less dependent on a single crop.
    e. Economic independence of smallholder farmers: Fair crop prices and access to markets give smallholder farmers a lot of power, which improves their social and economic situation.
2 . National economy
    a. **Agricultural employment:** A lot of people work in the agricultural sector, with arable farming being a major part of this. This greatly reduces the rural-to-urban migration.
    b. **Food price stability:** A stable supply of domestically produced arable crops helps to control food prices, contributing to economic and social stability.
    c. **Raw materials for industries:** Food processing, textiles and biofuels companies all need raw materials to stay in business, and arable crop production helps in providing such raw materials for them.
    d. **Industrial growth:** Turning crops into different products helps agri-processing industries stay in business and creates more jobs in sectors such as milling, oil extraction, and food packaging.
    e. **Foreign exchange:** Ghana gets a lot of foreign exchange from selling crops that can be grown on the land.

f. **Trade balance:** High export volumes positively impact Ghana's trade balance, reducing deficits and improving economic stability.

g. **Contribution to gross domestic product (GDP):** Arable crops are a substantial part of the agricultural sector, contributing significantly to the GDP, especially in agrarian economies like Ghana.

h. **Rural infrastructure development:** Successful crop production can lead to the growth of rural infrastructure such as roads, storage facilities and irrigation systems.

i. **Community investment:** Increased income from crop sales often results in greater investment in local communities, including education, healthcare and other services.

Activity 2.1: Meaning and importance of arable crops

Look for two friends to form a group of three. Browse the Internet for the meaning and importance of arable crops to your community. Again, search for the factors that influence successful arable crop production, and discuss the information among yourselves.

Activity 2.2: Economic importance of arable crops

Visit at least three different crop farmers and observe the crops they grow. Alternatively, visit at least three traders who deal with grains in your community. Ask questions about what arable crops are grown and the economic importance of cultivating them and take down relevant notes. Write individual reports on your visits to the farmers or the traders and share your findings with other colleagues.

STARTUP PACKAGES OF ARABLE CROP ENTERPRISES

To ensure successful farming and business operations, starting an arable crop enterprise requires several steps and a reasonable investment. Start-up packages for arable crop enterprises are valuable resources that new crop farmers seek and assemble to establish profitable and sustainable agricultural ventures. Here are some common start-up packages and considerations:

1. Initial capital: To start an arable crop enterprise, you need to get money from loans, grants, family investment or investors. However, an individual can also

start an arable crop enterprise with his/her own capital and plough back the profit gained to grow the capital gradually.

2. Land acquisition and preparation

a. **Land purchase or lease:** Initial investment for purchasing or leasing land suitable for arable crop cultivation is important for successful crop production.

b. **Soil testing:** Soil is tested to determine soil fertility and the need for amendments. Testing the pH of a particular type of soil is essential for effective arable crop production. Acidic soils or soils with high alkaline content are not good for crop production.

c. **Land clearing and preparation:** This includes ploughing, levelling and possibly drainage systems. Land clearing includes the removal of stumps, stones or rocks that may hinder the smooth ploughing of the land. Harrowing can also be carried out after ploughing to break up soil lumps as well as levelling the land for smooth sowing of seeds. Drainage channels should be created to allow excess water to pass through to prevent flooding on the farm.

3. Seeds and planting materials

a. **Certified seeds:** High-quality seeds of the chosen arable crop variety. A germination test should be done on seeds before sowing to ensure proper germination of seeds. The variety of the seed should be known by the farmer in order to know the time that the crop will take before maturity.

b. **Nursery establishment:** For crops that require seedlings before transplanting. Nursery beds should be made properly, and seeds nursed on them and properly catered for from germination up to the period of transplanting. Watering, fertilisation, fencing and mulching should be carried out to ensure the production of healthy seedlings for transplanting.

4. Farm machinery and tools

a. **Tractors and implements:** For ploughing, planting, cultivating and harvesting.

b. **Hand tools:** Such as hoes, machetes, and spades.

5. Labour: Hired, solicited or family labour for farm activities like planting, maintenance and harvesting.

6. Training programmes: These are for regular education and for updating workers on best practices.

7. Fertilisers and soil amendment materials

a. **Organic and inorganic fertilisers:** These will be selected based on soil test results and local recommendations.

b. **Lime or gypsum:** For pH adjustment, if necessary.

8. Pest and disease control chemicals, equipment and technologies

a. **Pesticides and herbicides:** For pest, disease and weed management.

b. **Biological control agents:** These include beneficial insects or microbial treatments.

9. **Irrigation systems**

a. **Drip or sprinkler systems:** Depending on the crop and water availability.

b. **Water storage facilities**, such as tanks or ponds.

10. **Storage and post-harvest handling**

a. **Storage facilities:** To hold harvested crops for the future and also protect them from pests and the weather. These include silos, barns as well as sacks, for the storage of gains and tubers.

b. **Drying equipment:** To reduce moisture content and pest load before storage. Dryers can be used to reduce the moisture content in grains for it to be stored for future use.

11. **Transportation:** This involves the movement of goods from one location to the other. It includes the following:

a. **Logistics planning:** For efficient movement of goods.

b. **Haulage vehicles:** For transporting inputs and harvested crops.

12. **Administrative setup**

a. **Insurance:** Insurance packages for crops, equipment and liability must be considered.

b. **Accounting and record-keeping systems:** To manage finances and track expenses.

13. **Market research and sales issues**

a. **Market analysis:** Understanding demand, pricing and competition.

b. **Sales agreements:** Establishing contracts with buyers, cooperatives or processors.

c. **Marketing strategies:** Developing a plan to promote and sell the produce.

14. **Regulatory compliance**

a. **Permits and licenses:** Ensuring compliance with local agricultural regulations must be done to ensure the smooth running of the crop enterprise.

b. **Environmental impact assessments:** It is the assessment of the environmental consequences of a plan, policy, programme, or actual projects prior to the decision to move forward with the proposed action. This should be done as required by law.

ITEM	COST(GH₵)
Land acquisition and preparation	
Lease 10 hectares of arable land per year	2,000.00
Soil testing and amendments	500.00
Land clearing and preparation	2,500.00
Seeds and planting materials	
Certified maize seeds	400.00
Fertilisers and pest control	
Fertilisers	2,500.00
Pesticides and herbicides	600.00
Irrigation and equipment	
Drip irrigation system	3,500.00
Tractor lease per year	3,000.00
Basic hand tools	1,500.00
Labour	
Labour for planting/harvesting	3,500.00
Storage and transport	
Temporary storage facility	2,000.00
Transportation costs	3,000.00
Administrative costs	
Initial capital and contingency fund	6,000.00
Insurance and legal fees	5,500.00
Total estimated initial investment	36,500.00

Example of a Start-up Package for a Small-scale Maize Farming Enterprise

NB: The above are only hypothetical costs. The actual costs and requirements will vary based on factors like the crop type, scale of the enterprise, local conditions and market dynamics.

Project Work

1. Visit a successful arable crop farmer to observe, ask questions and take field notes on start-up packages using a prepared questionnaire.
    a. A sample questionnaire to use when you visit the farms should include:
    b. What are the requirements needed to start an arable crop enterprise?
    c. How did you start the farm?
    d. What factors did you consider when establishing the farm?
    e. How were you able to fund your project?
2. Administer the questionnaire on start-up packages for arable crop enterprises.
3. Analyse your findings and determine how the responses will help you start a farm.
4. Assess the requirement for starting an arable crop and prepare a budget for a start-up package.
5. Write a report on the activities carried out and share your findings with colleagues.

PATTERNS OF GROWTH OF SUCCESSFUL ARABLE CROP ENTERPRISES

Characteristics and growth patterns of arable crop enterprises

This refers to the trends, characteristics, or behaviours observed in the development or expansion of arable crop farming over a specific period. Enterprises that grow arable crops and are successful have certain characteristics and growth patterns that help them stay in business and make a profit. Below is a comprehensive catalogue of these features:

Characteristics of Successful Arable Crop Enterprises

1. **Crop selection and diversification:** Successful arable crop enterprises select crops that do well in the local climate, soil, and market conditions. They grow and rotate different crop varieties to spread risk and increase resilience against pests, diseases, and market fluctuations.
2. **Technology adoption:** Precision agriculture involves GPS, drones, and data analytics to optimise planting, irrigation and harvesting. To get more crops grown, farmers also invest in modern machinery for planting, spraying, and harvesting. Biotechnological methods like genetically modified crops with enhanced resistance to pests and diseases for larger yields are also adopted.
3. **Efficient resource management:** These enterprises make sure soil stays fertile by testing it regularly, using organic matter and crop rotation. Efficient irrigation systems, water conservation practices, and drought-tolerant crop varieties are also used.
4. **Financial planning and management:** Detailed financial planning is necessary to control costs and maximise profit. In the same way, strong relationships with financial institutions ensure access to credit for investment in technology and inputs. To manage risk, crop insurance and hedging strategies are often used to protect against price volatility and natural disasters.
5. **Market analysis:** Successful farmers understand the market demand and grow crops with high market demand and favourable price trends. Crops are produced, processed and packaged to make them more valuable and thus increase profitability.
6. **Sustainability practices:** These enterprises practise sustainable farming such as conservation tillage, integrated pest management and use of renewable energy. Maintaining biodiversity and adapting to climate change are some of the ways to ensure the long-term viability of the farming enterprise.

Patterns of Growth in Successful Arable Crop Enterprises

1. Scalability: A gradual increase in the area under cultivation and investment in infrastructure will ensure incremental expansion. Expansion is necessary since cost reduction could also be achieved through large-scale operations.
2. Innovation and adaptation: Seeking and applying new technologies and farming practices to improve productivity and efficiency. Flexibility to adapt to changes in market conditions, climate and regulatory environment also promotes growth.
3. Collaboration: Partnerships with other farmers, agribusinesses, research institutions and government agencies to enhance growth.
4. Sustainability and resilience: Practices that ensure the sustainable use of natural resources, such as cover cropping; crop rotation and organic matter addition, should be used for resource conservation. Strategies to withstand economic and environmental shocks should be deployed.

Activity 2.3: Successful arable crop enterprises

In pairs, browse the Internet to identify and list three characteristics of successful arable crop enterprises, and discuss your findings with other friends.

Activity 2.4: Factors affecting growth patterns

Identify at least three factors that affect the growth patterns of arable crop enterprises and discuss your findings with friends.

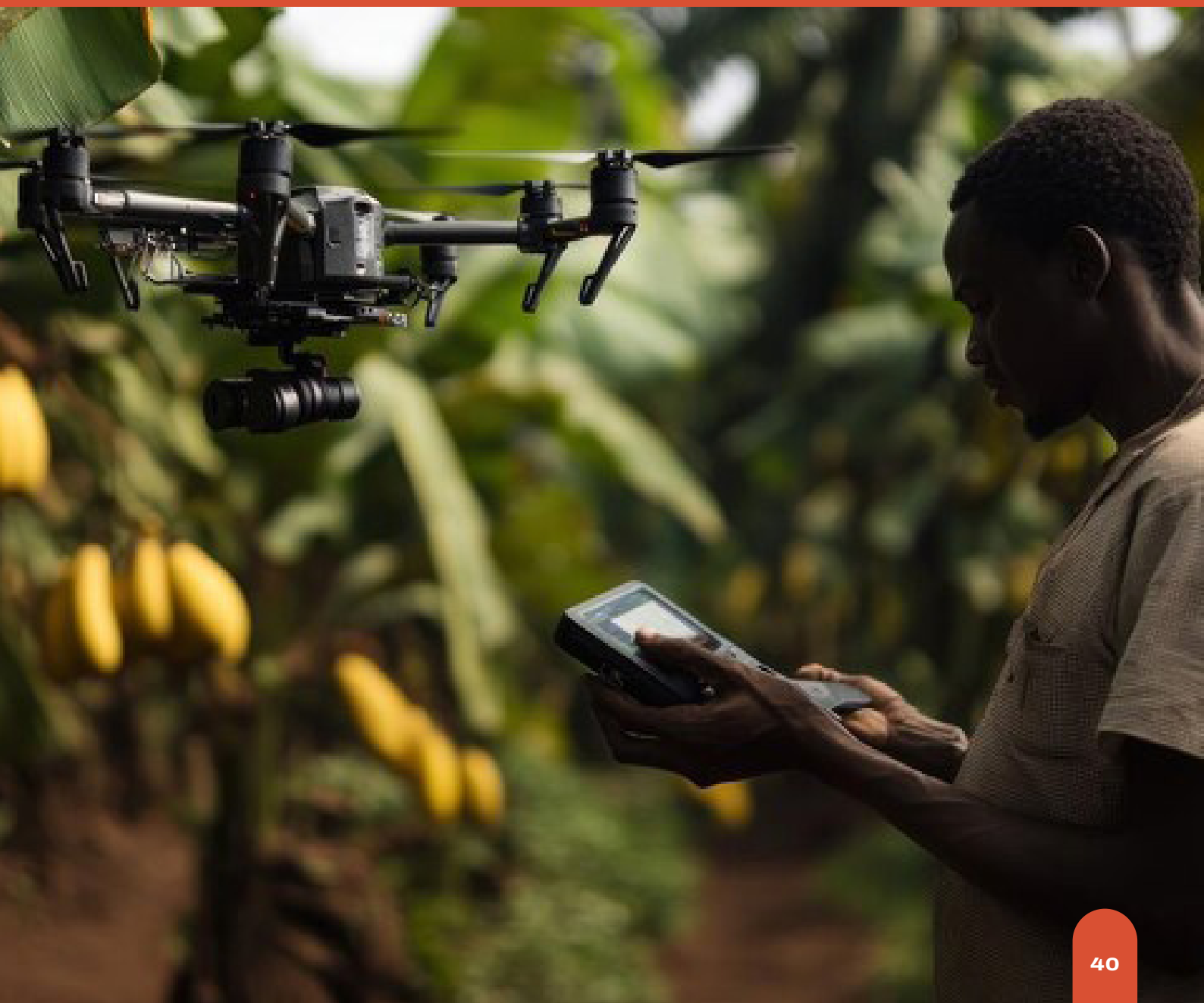
REVIEW QUESTIONS

1. Discuss four factors that influence arable crop production.
2. Describe four components of a start-up package for an arable crop farm.
3. Explain four factors that affect the growth patterns of arable crop enterprises.
4. Explain the relevance of studying factors that affect the growth pattern of arable enterprises.

SECTION

3

EMERGING TECHNOLOGIES IN ARABLE CROP PRODUCTION



New Dawn in Agriculture

Emerging Technologies in Agriculture

INTRODUCTION

In today's rapidly advancing agricultural landscape, you must understand the role of emerging technologies in enhancing arable crop production. This section introduces you to two key areas: precision agriculture and the mini-sett technique in yam production. In this section, you will explore precision agriculture, which involves using data-driven technologies to optimise crop management, improve yields, conserve resources, and promote sustainability in arable crop enterprises. In addition, you will learn about the mini-sett technique for yam production, which allows farmers to increase the efficiency of yam propagation by using smaller yam cuttings to grow new plants. You will understand the advantages of this method over traditional techniques, including increased yield, reduced wastage, and cost efficiency. By the end of the section, you will be equipped with practical knowledge and skills to apply these innovative approaches to modern farming practices. This will prepare you for real-world agricultural challenges and innovations.

KEY IDEAS

- Mini-sett technique in yam production: This is a technique that involves cutting yam tubers into smaller pieces, known as mini-setts, for propagation, increasing the number of plants from a single tuber and optimising planting material.
- Precision agriculture: A modern farming approach that utilises advanced technologies and data analytics to optimise farming operations such as seeding, irrigation, and fertiliser application, improving crop yields and reducing environmental impacts.
- Technology advancement: This refers to innovations enhancing agricultural practices, leading to improved productivity and reduced labour.
- Variable rate seeding: This refers to precision agriculture that adjusts seeding rates based on soil fertility and moisture levels, ensuring optimal plant density and enhancing crop growth in different field zones.
- Water conservation techniques: This refers to precision irrigation systems that minimise water wastage by applying the exact amount of water needed in specific areas, leading to efficient water use and improved crop health.

PRECISION AGRICULTURE IN ARABLE CROP ENTERPRISES

Meaning And Importance Of Precision Agriculture In Arable Crop Enterprises

Precision agriculture, sometimes called "precision farming", is the use of advanced technologies and agronomic practices, based on Artificial Intelligence (AI), to manage and optimise farm operations to improve crop quality, profitability, and sustainability. It includes collecting and analysing data on soil type, crop health, weather conditions and other factors so that smart choices can be made about planting, irrigation, fertiliser application and harvesting. The goal of precision agriculture is to optimise crop yields by only using the right number of inputs, thereby minimising waste, reducing negative environmental impact and promoting sustainable farming practices.

Some advanced technologies deployed in precision agriculture for arable crop production include:

1. GPS and GIS technology: Global Positioning Systems (GPS) and Geographic Information Systems (GIS) make it possible for farmers to accurately map and analyse soil, crop and farm locations and conditions precisely.
2. Drones: Take high-resolution pictures from the air to monitor crop health and identify pest incidence and severity to inform crop management decisions.
3. Variable Rate Technology (VRT): Application of inputs like fertilisers and pesticides at varying rates because of the heterogeneity of the soil and pest situations across the field. Drones' pictures and data are used by VRT to make decisions.
4. Soil sensors: These sensors check the type of soil, its moisture content, pH level, and nutrient content to help with decisions about when to water and add fertiliser to the soil.
5. Automated irrigation systems: These automated irrigation systems turn on and off by themselves based on how wet the soil is and how much water the crops need. The automation is based on sensors and weather forecasts. Hence, the crop only gets the right amount of water when it needs it.
6. Weather stations: Weather conditions are monitored in real-time to inform planting, harvesting and other farm operations.
7. Precision planters: These are manual or tractor-mounted implements that sow seeds at the recommended depths and spacing for uniform seedling emergence and crop growth.
8. Harvesters: These robots harvest crops at the optimal times for maximum yield and quality.

9. Big data analytics: Collect, store, and analyse data from many sources to make predictive models and help make informed decisions.

Figure 3.1a: Spot spraying drones

Figure 3.1b: Automated irrigation systems

Importance of Precision Agriculture in Arable Crop Enterprises

Precision agriculture is important in arable crop production for the following reasons:

1. Variable rate seeding: Precision planters adjust seeding rates based on soil fertility and moisture levels. This ensures that each field zone has the right number of plants.
2. Water conservation: Precision irrigation systems use the right amount of water in the right areas at the right time, so less water is wasted.
3. Reduced chemical use: Precision agriculture reduces the use of herbicides, pesticides and fertilisers by only putting the right amount of each where it's needed. This lowers the cost and damage to the environment.
4. Improved decision-making: Because precision agriculture is built on data, farmers can make more informed decisions because they have a better understanding of how differences in the field affect crop performance.
5. Increased efficiency: Precision agriculture automates a lot of farming processes, reducing labour costs and improving productivity.
6. Real-time monitoring: Precision agriculture enables farmers to monitor their crops in real-time. This means that if there are any problems, farmers can move quickly to fix them.
7. Minimising crop damage and loss: Harvesting robots pick fruits, vegetables and other crops with precision, reducing labour costs and minimising crop damage and loss.
8. Improved crop yields: Precision agriculture helps farmers handle their fields more accurately, which ensures higher yields. Technologies like yield monitors and remote sensing give farmers more detailed information on field variability, which helps them make better crop management decisions.

9. Environmental sustainability: Precision agriculture encourages sustainable farming practices, which lowers the environmental impact of arable crop production.

Challenges of Precision Agriculture in Arable Crop Enterprises

Some of the challenges of precision agriculture in arable crop production include:

1. Investment in equipment: The cost of purchasing and maintaining precision agriculture equipment (e.g. GPS-guided tractors, drones, and sensors) is high, which can be a significant barrier to farmers adopting precision agriculture.
2. Data sharing and ownership concerns: Issues related to farm data sharing and ownership may pose obstacles to the widespread use of AI in agriculture.
3. Training and education: Farmers may require training and education to effectively integrate precision agriculture technologies into their operations.
4. Interoperability: Different technologies and equipment may not always be compatible with each other, making it difficult to integrate data from various sources.
5. Sensor accuracy: The accuracy and reliability of sensors used for soil, crop and weather monitoring can vary, leading to potential errors in decision-making.
6. System malfunction and failures: Dependence on high-tech equipment means system failures (e.g. GPS malfunctions and drone crashes) can disrupt farming operations.
7. High-level technical know-how: Implementing precision agriculture requires technical knowledge and skills many farmers may not possess. This includes understanding how to use data analytics tools and interpreting the results.
8. Reliable Internet connectivity: This is crucial for real-time data collection, transfer and analysis. Rural areas, where many farms are located, often have poor Internet infrastructure.
9. Consistent and reliable power supply: This is necessary for running high-tech equipment. In some regions, power outages can disrupt precision agriculture operations
10. Changing weather patterns and extreme weather events: Can affect the accuracy and reliability of precision agriculture models and predictions.

Some Recommended Solutions to Challenges with precision agriculture in arable crop enterprises

To address these challenges with precision agriculture in arable crop enterprises, several measures can be taken:

1. Government and institutional support: Governments and agricultural institutions can provide subsidies, training programmes and technical support to help farmers adopt precision agriculture.

2. Collaboration and partnerships: Partnerships between technology providers, researchers and farmers can facilitate the development of more user-friendly and affordable precision agriculture innovations and solutions.
3. Research and development: Improving upon the accuracy, reliability and affordability of precision agriculture, through research, is essential.
4. Infrastructure development: Investment in rural Internet and power infrastructure can support the widespread adoption of precision agriculture.
5. Awareness and education: Increasing awareness about the benefits of precision agriculture and providing accessible educational resources can help overcome resistance and skill gaps

Activity 3.1: Discovering precision agriculture in action

In pairs, surf the Internet for the meaning, components and importance of precision agriculture in arable crop production. Again, search for the benefits and challenges of precision agriculture. Discuss your findings and present a report to your teacher.

Steps to follow to achieve **Activity 3.1:**

1. Pair up with a friend and work as a team of "agri-tech explorers" to uncover the wonders of precision agriculture.
2. Use computers, tablets, or phones to surf the Internet for information about precision agriculture. You could look for the key components like GPS, sensors, drones, and automated systems.
3. Write down what these technologies do and why they are important for modern crop farming.
4. Find and watch videos or view images that show how precision agriculture works in real life.
5. Look for technologies such as drones spraying crops or automated irrigation systems in action. You could also use YouTube or educational websites to find these examples.
6. After your research and video viewing, talk with your partner about what you have learned, and discuss both the benefits and challenges of using precision agriculture in arable crop production.
7. You could include the following in sharing your thoughts and discussions:
    a. How do these technologies help farmers grow crops more efficiently?
    b. How do they save water, reduce chemical use, and increase crop yields?
    c. What problems might farmers face when using these technologies (e.g. cost, maintenance, technical skills)?
    d. What solutions can address these challenges?

8. Work together to create an informative report. In your report, explain:
   a. What is precision agriculture?
   b. What are the key technologies used, and how do they help farmers?
   c. Why is precision agriculture important for arable crop production?
   d. What are the benefits and challenges of precision agriculture?
   e. How can these challenges be addressed to make precision agriculture more accessible and effective?
9. Present the report to your teacher

Activity 3.2: Hands-on variable rate seeding experiment

Using the same partner, experiment with variable rate seeding (as an example of precision agriculture) in the school garden/community.

Follow the information below to experiment successfully:

1. **Materials for the experiment**
   a. Same-sized containers (e.g. small pots or seed trays) – 3 or more per group.
   b. Soil – Enough to fill each container to the same level.
   c. Seeds – Select any type of seed (e.g. maize, beans, or other suitable seeds) with a sufficient quantity for variable seeding rates.
   d. Water – To water the seeds consistently across all containers.
   e. Measuring cup – To ensure equal amounts of water are used for each container.
   f. Ruler or measuring tape – To measure plant height during growth observations.
   g. Labels or markers – To label each container with the seeding rate (e.g. 2 seeds, 5 seeds, 8 seeds).
   h. Notebook or observation sheet – For recording plant growth data (e.g. plant height, leaf colour, stalk thickness).
   i. Pen or pencil – For taking notes and filling in observation charts.
   j. Calculator or phone with calculator – For group data analysis, to calculate averages and identify patterns in plant growth.
   k. Sunlight or grow lights – Ensure all containers receive equal light exposure.
2. **Procedure (From methods to presentation of findings):**
   a. With your partner, gather several same-sized containers and plant different numbers of seeds in each (e.g. 2 seeds, 5 seeds, and 8 seeds).

Make sure to use the same soil type, amount of water, and sunlight for each container to keep things fair!

b. Over time, keep track of how your plants grow. Pay close attention to details like:
   i. Plant height
   ii. Leaf colour
   iii. Stalk thickness
   iv. Number of leaves
   v. Any other differences

c. Record your observations regularly and note how each group of plants is developing based on the number of seeds planted.

d. After collecting your observations, pool your data with your partner and work together to calculate averages for characteristics like plant height and stalk thickness for each seeding rate.

e. Use simple statistics to identify patterns—how does planting more or fewer seeds affect plant growth? Discuss your findings with your group.

f Based on your data, decide what the results tell you about variable rate seeding. Did planting more seeds result in healthier, taller plants, or did it cause overcrowding?

g. Present your findings to the class.

THE ROLE OF THE MINI-SETT TECHNIQUE IN PROMOTING YAM PRODUCTION

Mini-setts technique is used in yam production to optimise the use of planting material and improve the efficiency of yam propagation. Mini-setts are pieces of cut yam tubers, typically weighing about 25-50g each, with at least one bud (eye) which can sprout and grow into a new plant. Objectives of mini-sett technique in yam production include:

1. To optimise the available yam tubers by cutting them into smaller pieces to increase the number of plants that can be propagated from a single tuber.
2. To minimise wastage of planting material and make the best use of healthy tubers.
3. To increase the number of yam plants per unit area, potentially leading to greater yields.
4. To propagate yam plants from healthy, disease-free mini-setts to reduce the incidence and spread of diseases in yam fields.

5. To reduce the overall cost of planting materials to make yam cultivation more affordable and profitable for farmers, especially smallholder and resource-limited farmers.

Steps involved in using yam mini-sett technique

Implementing the mini-sett technique in yam production involves the following systematic steps:

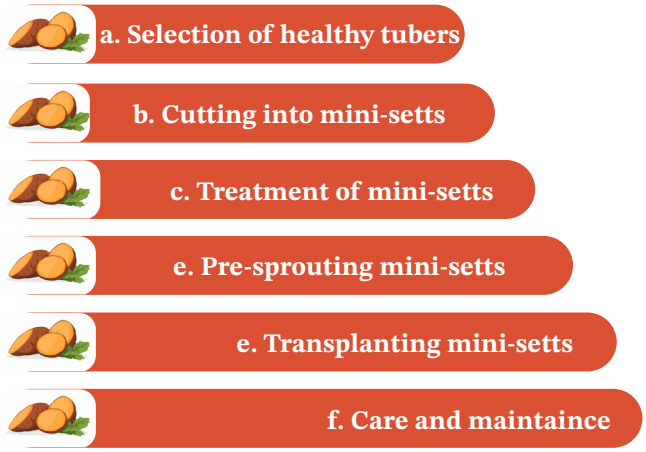


Figure 3.2: Steps involved in using yam mini-sett technique

a. Selection of healthy tubers: Select disease-free, mature yam tubers with good physical characteristics, without signs of rot, pest, or disease.

b. Preparation of mini-setts: Cut the selected tubers into small pieces called mini-setts, each weighing approximately 25-50 grams. Each piece should have at least one viable bud (eye). Aim for uniform sizes to ensure uniform growth and development.

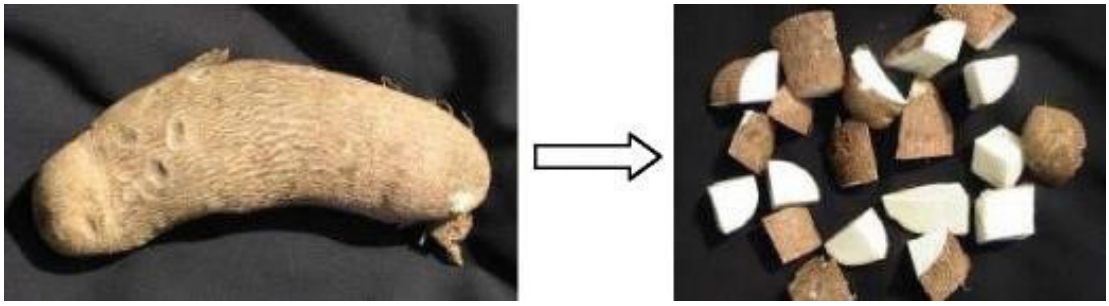


Figure 3.2: Preparation of mini-setts

c. Treatment of mini-setts: Treat the cut surfaces of the mini-setts with a fungicide or wood ash to prevent fungal infections and rotting. A common treatment involves dipping the mini-setts in a fungicide solution for a few minutes. Allow the treated mini-setts to dry in a shaded, well-ventilated area for one day to ensure the fungicide adheres and the cut surfaces heal.

Figure 3.3: Demonstration of fungicide application to mini-setts in the Sene West District, Bono East Region of Ghana.

d. Pre-sprouting: Prepare a nursery bed or trays filled with a suitable growth medium such as sawdust, soil, or a mixture of soil and compost.
    i. **Planting in the nursery:** Plant the treated mini-setts in the nursery bed, ensuring they are spaced adequately.
    ii. **Watering:** Water the nursery bed regularly to keep the soil moist but not waterlogged.

e. Transplanting in the field: It takes 2 – 3 weeks for the mini-setts to sprout. Transplant the pre-sprouted mini-setts onto prepared ridges or mounds in the field when the sprouts are still short and have not developed into long vines or produced broad leaves. Plant each mini-sett soon after removal from the nursery, at a depth of 10-15 cm on the mounds or ridges, with the sprout facing upwards. Space the mini-setts one meter apart within rows and one metre between rows, to allow for proper growth and development.

Figure 3.4: Preparing ridges for transplanting sprouted yam mini-setts in the Sene West District

f. Care and maintenance (cultural practices)

i. **Watering:** Provide adequate water, especially during dry periods, to ensure the soil remains moist but not soggy.

ii. **Staking:** Stake the yam plants to support the vines in order to reduce disease and pest infestation.

iii. **Weed control:** Regularly weed the field to prevent competition for nutrients and water. Mulching can help reduce weed growth and retain soil moisture.

iv. **Fertiliser application:** Apply appropriate fertilisers based on soil tests and crop requirements to ensure the plants receive adequate nutrients. (90 Kg N, 50 Kg P, 75 Kg K per ha).

v. **Pest and disease management:** Monitor the field for signs of pests and diseases and take necessary remedial actions. If applying insecticides or fungicides, follow guidelines for application rates and safety measures.

Harvesting and post-harvest handling

a. Timing: Harvest the yams when the vines start to yellow and die back, or 8-12 months after planting, depending on the yam variety.

b. Digging the tubers: Dig up the tubers carefully to avoid damage. Use appropriate tools (earth chisel or hoe) to loosen the soil around the tubers before lifting them.

c. Curing tubers: Cure the harvested yams by storing them in a well-ventilated, shaded area for a few days to allow the epidermis to harden and any wounds to heal.

d. Storage: Store the cured yams in a cool, dry, well-ventilated place to prolong shelf life and maintain quality.

Benefits of the mini-sett technique over the traditional yam production method

Mini-sett technology offers several significant benefits over the traditional method, particularly for smallholder farmers and those aiming to optimise their resources and improve yields. The key benefits include:

a. Efficient use of planting material: Traditional yam planting requires large tubers, which can be wasteful.

b. Uniform growth and development: Mini-setts result in more uniform plants, which simplifies crop management and harvesting. The uniformity allows for better timing of farming operations.

c. Effective disease control and healthier plants: Using treated mini-setts reduces the risk of disease transmission from the mother tuber to new plants. Healthier planting material leads to vigorous and more resilient plants.

d. Increased yield: More mini-setts can be planted per unit area with greater productivity.

e. Cost-effective: Farmers spend less buying seed yams than on large yam tubers for planting, making it a more economical option. Savings on planting material can be redirected to other inputs like mound preparation and fertilisers.

f. Resource maximisation: Smallholder farmers can use limited resources better, increasing their productivity and profitability.

g. Environmental benefits: The technology promotes sustainable farming practices by maximising resource use and reducing the need for extensive cultivation.

h. Improved post-harvest handling and marketing: The mini-sett technique helps to produce tubers that are easier to handle, store, transport and market due to their uniform size and quality. Healthier plants often produce better-quality tubers, which can fetch higher prices.

By following the steps outlined above, farmers can produce seed yams either as a business venture or for their ware yam production. Overall, mini-sett technology enhances the productivity, profitability and sustainability of yam farming, making it an attractive option for farmers.

Activity 3.3: Mini-sett technique in yam production

In pairs, discuss the meaning and objectives of using the mini-sett technique in yam production. Again, compare the benefits of the mini-sett technique and the traditional method of yam production, and present your findings on posters and paste them on the classroom wall.

Activity 3.4: Mastering the yam mini-sett technique

With the same partner, practise the steps of the mini-sett technique in yam production.

Steps to follow:

Identify and gather materials

1. Discuss with your partner and list all the materials needed for the mini-sett technique. You could think about items like **yam tubers, sharp knives, fungicide or wood ash, trays or bags filled with soil or sawdust, water,** and **plastic containers or jute sacks** for planting
2. Work together to gather the materials you need for the practice.

Group practice – Cutting the mini-setts

1. In your group, carefully cut the yam tubers into mini-setts. Ensure you follow the guidelines below.

2. Prepare the tuber for cutting by placing the yam tuber on a cutting surface and ensuring your knife is clean and sharp for smooth cuts.
3. Identify the buds/eyes by carefully inspecting the yam tuber for buds or eyes, ensuring each mini-sett has at least one to enable successful growth.
4. Carefully cut the yam tuber into smaller pieces (mini-setts), ensuring each piece weighs 25-50 grams and contains at least one bud or eye without damaging them.
5. After cutting the tuber into mini-setts, treat each piece with fungicide or wood ash to protect it from disease.
6. Handle the knife carefully, taking turns so that your partner can participate, and ensure everyone is focused to avoid accidents, with only one person cutting at a time.
7. After cutting, discuss with your partner how each step was carried out and any challenges faced, ensuring all mini-setts have buds or eyes intact and have been treated with fungicide or wood ash.

Prepare the nursery

1. Place the treated mini-setts into trays or bags filled with **soil or sawdust**. Make sure you leave enough space between them for healthy growth.
2. Water your mini-setts regularly and observe closely as they start to sprout.

Transplant and caring for the sprouts

1. When the mini-setts have sprouted, transplant them into **mounds or ridges**, or plant them into **jute sacks or plastic containers** filled with soil. Make sure the soil is well-prepared to support the growth of the plants.
2. Take care of your plants by watering them regularly and checking on their growth.

Observe and record

1. As your plants grow, make observations about how well they are developing. Keep track of their progress by recording details such as the size of the plants, the number of leaves, and the general health of the sprouts
2. Share your observations with your group and discuss what you notice about the growth process

Group discussions and reflection: Once your plants have matured, reflect with your partner on the entire process. You could consider the following questions: a) What were the important steps in the mini-sett technique? b) Why is it important to treat the mini-setts before planting? c)How does this technique help farmers grow more yams with fewer resources?

Summarise your findings and share your experiences with other classmates.

EXTENDED READING

- Bosompem, M. (2020). Current state of precision agriculture in Ghana: Opportunities and challenges. University of Cape Coast, Cape Coast, Ghana. Senior Lecturer and Country Rep. for Ghana, International Society of Precision Agriculture, USA.
- Lee, W. S. (2017). Precision agriculture and smart-sensing systems for crop management. University of Florida, Institute of Food and Agricultural Sciences. Retrieved from https://ufrfprofessors.research.ufl.edu/lee-won-suk/

REVIEW QUESTIONS

1. Explain at least three specific applications of precision agriculture in arable crop production.
2. Discuss the importance of precision agriculture in arable crop production.
3. Explain three challenges that could hinder the use of precision agriculture in Ghana and how to address them.
4. Discuss the steps in the yam mini-sett technique.
5. Compare the mini-sett technique with the traditional method of yam production.

SECTION

4

AGRICULTURAL MACHINERY

New Dawn in Agriculture

Agricultural Machinery

INTRODUCTION

In arable crop production, machinery plays a crucial role in increasing efficiency and reducing the physical labour traditionally associated with farming. This section introduces you to the various types of machinery used in the cultivation of cereals, legumes and tubers. In this section, you will identify and classify different types of farm machinery, such as those used for soil preparation, planting, addition of fertiliser, irrigation, and harvesting. You will also have the opportunity to operate these machines, gaining practical experience and learning important operational skills and safety precautions. Understanding how to properly use and maintain this machinery is essential to ensuring safe, effective, and sustainable farming practices. Additionally, this section will help you build confidence and responsibility, preparing you for real-world agricultural work, where the efficient use of machinery is key to modern farming success.

KEY IDEAS

- **Agricultural machinery:** Refers to mechanical structures and devices used in farming or other agricultural activities.
- **Calibration:** This refers to adjusting machinery to ensure accurate application of inputs like water or chemicals.
- **Foliar fertiliser:** A liquid fertiliser applied directly to plant leaves for nutrient absorption.
- **Post-harvest operations:** Activities that are carried out after harvesting crops.
- **PPE:** Personal protective equipment used to ensure safety while operating machinery.

DIFFERENT TYPES OF MACHINERY USED IN ARABLE CROP PRODUCTION

Identification of different types of machines used in arable crop production

There are different types of machinery used in arable crop production. These machines are used for different purposes, ranging from cultivation, harvesting and processing.

These machines will be identified and classified based on their uses in arable crop production. The different types of machines commonly used include:

1. Ploughs: Used for primary tillage to turn over the soil, burying crop residues and weeds.
2. Harrows: To break clods and provide a finer soil structure. Types include disc harrows, tine harrows and chain harrows.
3. Cultivators: For secondary tillage, to stir and pulverise the soil, before planting or during crop growth.
4. Rotary tillers: A rotary tiller, known as a rototiller, rotavator, or rotary hoe, is an agricultural machine used for secondary tillage. Rotary tillers are essential in modern agriculture to prepare seedbeds. They are hitched to a tractor during operation. Their use improves soil structure and promotes better root growth. The tilling action of the blades helps to uproot and bury weeds, reducing competition with the crops, aerating the soil and improving water infiltration and drainage. They come in two forms: manually operated, engine-powered tillers, suitable for small-scale farming or gardening (walk-behind rotary tillers), and the larger tractor-operated tillers, for larger fields and commercial farms.

Figure 4.1: A rotary tiller

Figure 4.2: Tractor-mounted rotatory tiller

5. Seed drills: Seed drills are precision planting devices for planting seeds at specific depths and uniform rates. There is minimal disturbance to the soil, thus maintaining soil structure and health. Seed wastage, time and labour required for planting are reduced.

Figure 4.3: Seed drills (shutterstock.com/search/seed-drill-machine)

6. Planters: Planters sow seeds in rows at specific intervals. They are similar to seed drills but often have more advanced features for the precise planting of various crops. Planters can plant crops such as maize, soybeans and sunflowers. Modern planters include GPS, variable rate technology and real-time monitoring systems. They increase planting speed and reduce labour costs.
7. Broadcast seeders: They are also known as spreaders. They spread seeds and fertilisers evenly across large fields. You can hold a broadcast seeder in your hand, attach it to a tractor, or tow-behind models. With their adjustable parts, you can change how fast and where seeds and fertilisers are spread. They work quickly, but not as precisely as planters or drills. This can cause seeds to be spread out unevenly and a lot of seeds to be wasted due to overlaps in covering.

Figure 4.4: Hand-held broadcast spreader

Figure 4.5: Tractor-mounted tow spreader

Figure 4.6: Tractor-operated broadcast spreader

8. Fertiliser spreaders: They distribute fertilisers evenly across the field, which helps to reduce waste, optimise nutrient use, and improve soil fertility and crop yields. They include broadcast spreaders, drop spreaders, rotary spreaders and pneumatic spreaders. They have adjustable settings for the rate and pattern of fertiliser distribution. Some models include GPS and variable rate technology for precise applications. This ensures even distribution of fertiliser, including granular, pellet and powdered forms.

Figure 4.7: Walk behind broadcast fertiliser spreader.

9. Sprayers: Sprayers dispense insecticides, herbicides, fungicides and liquid fertilisers. Types include hand-held and backpack or knapsack sprayers and boom sprayers. Sprayers require regular cleaning and maintenance to ensure proper functioning and longevity. They must be properly calibrated before being used to minimise environmental contamination.

Figure 4.8: Manually-operated knapsack sprayer

Figure 4.9: A boom sprayer

10. Cultivators: Cultivators are essential agricultural implements used to control weeds and aerate the soil around growing crops. They help improve soil structure, enhance nutrient availability and promote healthy crop growth. Types of cultivators include field cultivators, row crop cultivators, rotary cultivators (rototillers), chisel ploughs and spring-tooth harrows. Cultivator use enhances root growth and soil microbial activity, incorporates crop and weed residues into the soil, improves organic matter content, prevents waterlogging and enhances soil moisture retention.
11. Combines or combine harvesters: These machines combine three essential harvesting operations - reaping, threshing, and winnowing - into a single process, significantly reducing labour and time. Types of combines are conventional combines, rotary combines, and hybrid combines. They quickly handle large crops and are ideal for large-scale farming. Modern combines ensure minimal

grain damage and loss during the harvesting process. They are adaptable to harvest various crops, including wheat, barley, maize, soybeans and rice.

Figure 4.10: Pictures of different types of combine harvesters

Figure 4.11: A combine harvester at work

12. Grain dryers: Grain dryers reduce the moisture content of harvested produce for storage or further processing. Proper drying prevents spoilage, mould growth and insect infestations, preserving grain quality and market value. Properly dried grain can be stored for longer periods without degradation. The types of grain dryers include batch, continuous flow, column, bin and portable dryers.
13. Threshers: Threshers separate grains from their stalks and husks during or after harvest. They process cereals and legumes, ensuring efficient and effective separation of the edible parts from the chaff. Thresher types include drum, hammer mill, rasp bar, spike tooth and axial flow threshers. Threshers significantly reduce the labour and time required for manual threshing. Modern threshers ensure minimal grain damage and loss, preserving grain quality and increasing the speed and volume of grain processing essential for large-scale farming. They thresh crops, including wheat, rice, barley and soybeans.

Figure 4.12: Rice/wheat threshing machine

14. Wagons and trailers: Wagons and trailers are essential for transporting harvested crops, farm inputs, and other materials around the farm and from the field to storage or processing areas. They contribute significantly to the efficiency and productivity of farming operations. Types include grain and silage wagons, flatbed, dump, utility and liquid manure trailers and grain carts. They reduce the time and labour for transporting materials across the farm, enhance farm productivity, reduce the need for multiple trips and minimise fuel consumption.

Figure 4.13: A picture of a tractor and a wagon

Classification of different types of machinery used in arable crop production

The machinery used in arable crop production is classified into several categories based on its functions and stages of the crop production process.

1. Soil preparation machinery
    b. Ploughs: These are used to turn over soil for primary tillage.
    c. Harrows: They break up clods and refine soil.
    d. Cultivators: They stir and pulverise soil for secondary tillage.
    e. Rotary tillers: These prepare seedbeds with rotating blades.
2. Planting and sowing machinery
    a. Seed drills: They ensure precision planting at the correct depth and spacing.

   b. Planters: They ensure row crop planting at specified intervals.
   c. Broadcast seeders: These scatter seeds over large areas.
3. Fertiliser application and pest control machinery
   a. Fertiliser spreaders: They distribute fertilisers evenly.
   b. Sprayers: They are used to apply pesticides, herbicides, and fungicides.
4. Irrigation machinery
   a. Drip irrigation systems: They supply water directly to plant roots.
   b. Sprinkler systems: They distribute water over crops.
5. Crop maintenance machinery
   a. Cultivators: These control weeds and aerate soil around crops.
   b. Hoes: They are used for manual and mechanical weed removal.
6. Harvesting machinery
   d. Combine harvesters: They combine reaping, threshing, and winnowing.
   e. Pickers: Can discriminate between ripe and unripe fruits or crop heads.
7. Post-harvest handling machinery
   a. Grain dryers: They reduce the moisture content in grain.
   b. Threshers: They separate grain from stalks and husks.
   c. Wagons and trailers: These transport crops from the field to storage.
8. General machinery
   a. Tractors: These are versatile machines for pulling and operating implements.
   b. Loaders: These are used to move soil, manure, and other materials.

Activity 4.1: Identification and classification of farm machines

1. Get two friends, in addition to yourself, to form a group of three.
2. Visit a farm in your locality or any agricultural machinery dealers in your locality, to have real-world experience in farm machinery types, classifications and uses in arable crop production.
3. Ask questions about the types of machines seen, their classifications, as well as the benefits of using different types of machinery for arable crop production.
4. Listen attentively and write down relevant notes.
5. Write an individual report of your visit and submit it to your teacher.

OPERATING DIFFERENT TYPES OF MACHINERY FOR ARABLE CROP PRODUCTION

Precautions for Operating Farm Machines

Operating farm machines involves several precautions to ensure safety and efficiency.
Key Precautions include:

1. Operating manuals and guidelines: All operators should know and follow these guidelines.
2. Training and certification: All operators should be trained and certified in the operation of farm machinery, including emergency procedures and maintenance.
3. Personal protective equipment (PPE): Always wear appropriate PPE such as gloves, safety glasses, ear protection and steel-toed boots. Use high-visibility clothing to ensure operators are easily seen.
4. Safe operating procedures (SOPs): Start and stop machines according to the prescribed procedures. Never bypass safety features and avoid operating machinery when tired or under the influence of alcohol or other substances.
5. Regular maintenance and inspection: Check and maintain machinery regularly to keep machines in good working condition. Inspect machines before each use to identify any potential issues or defects.
6. Work environment safety: Keep work areas clean and free of obstructions. Ensure good lighting in areas where machinery is operated.
7. Emergency preparedness: A first aid kit and fire extinguisher should be readily available. Establish and communicate emergency procedures to all workers.
8. Proper storage and transport: Store machines properly when not in use to prevent unauthorised access and damage. Ensure machines are properly secured during transport to forestall accidents.
9. Awareness of surroundings: Be aware of other workers when operating machinery. Use mirrors and cameras, if available, to improve the visibility around machines.
10. Communication: Maintain clear communication with other workers, especially when performing tasks that require coordination.

Maintenance of Farm Machines

Maintaining farm machines is crucial for ensuring optimal performance, efficiency and longevity, which directly impact agricultural productivity.

Key practices for effective maintenance:

1. Regular inspections: Conducting routine inspections helps to identify signs of wear and tear, leaks, damage, malfunction, or any potential issues. Identified issues should be addressed promptly to forestall major repairs.
2. Scheduled servicing: The manufacturer-recommended servicing schedules should be followed for each machine, including changing oil, filters, and lubrication.
3. Fluid checks: The engine oil, hydraulic fluid, and coolant levels should be checked regularly. Fluids should be topped off as needed and filters replaced according to the manufacturer's schedule.
4. Lubrication: Lubricate moving parts regularly, such as bearings, gears, and chains. Use the correct type and amount of lubricant to prevent damage.
5. Scheduled maintenance: The manufacturer's schedule for routine maintenance, such as spark plug replacement and belt replacements, should be followed.
6. Regular cleaning and storage: Machines should be kept clean to prevent dirt and debris buildup that can cause corrosion or mechanical problems. Machines should be stored in dry, covered areas when not in use to protect them from weather damage.
7. Tyre pressure: Check tyre pressures regularly to maintain the recommended pressure for optimal traction and fuel efficiency.
8. Worn parts: Replace worn-out or damaged parts promptly with genuine spares to maintain performance and safety.
9. Record keeping: Keep detailed and accurate records of maintenance activities, repairs, parts replacements and inspections to track machine history and plan for future maintenance.
10. Pre-season preparation: Machines should be inspected and prepared for specific tasks such as planting or harvesting before each season begins.
11. Performance monitoring: Regularly monitor machine performance during operation to detect any signs of malfunction early on.
12. Professional assistance: Only authorised service professionals should be consulted when in doubt or for complex repairs.

Using a knapsack sprayer

The knapsack sprayer is the most common farm machine used in arable crop farming for insecticide and liquid fertiliser application. Its effectiveness varies because it is sometimes used in the wrong way. To reduce pesticide misuse and abuse, you need to know how to use the sprayer correctly.

1. **Sprayer calibration:** The sprayer should be calibrated to deliver the correct amount of chemicals. Reasons for the calibration include;

a. Sprayers come in different types, with varying tank sizes and delivery rates. Sprayer nozzles also differ in type, size and emission rate.

b. Human height and walking speed differ greatly; hence, no one can rely on the calibration of another to determine the amount of pesticide to use.

c. Crop architecture differs greatly, and canopy size changes with growth, needing different volumes.

2. Making a calibration stick: A farmer needs an implement to determine water volume in the sprayer tank without relying on the markings on the tank, which are 5-litre graduations. The stick is dipped into the tank at any stage of the spraying process to determine the water volume used, in order to calculate the volume sprayed over a unit area.

   a. Items required for making the calibration stick

      i. Knapsack sprayer

      ii. Pegs

      iii. Planting rope (garden/guiding line)

      iv. Garden tape

      v. Dry, straight, wooden rod

      vi. Clean water in jugs

      vii. or 0.5-litre beaker/measuring cylinder

      viii. Indelible marker ii.

   b. The process of making the calibration stick

      i. Place the sprayer on level ground

      ii. Mark out the sprayer base on the ground. All subsequent sprayer readings will be taken from the same spot.

      iii. Fill the sprayer with water, one litre or half a litre at a time.

      iv. Each time, dip the rod into the tank and mark the water level on the stick with the indelible marker.

      v. Repeat until the sprayer tank is filled (15 or 30 marks on the stick).

      vi. The calibration stick is now ready for use.

Spray volume calibration

1. Mark out a plot of land at least 10 m x 10 m

2. To get a straight baseline for the marked-out area, use Pythagoras' theorem (3 – 4 – 5 m) pegging method with the 4 m point on the selected base. For larger fields or greater accuracy, use 6 – 8 – 10 m to determine the straightness of the baseline.

3. Peg the crop row points (inter-row spacing), according to the planting distance of the crop, on the baseline.

4. Peg the opposite side of the baseline.
5. Stretch the garden line along the pegs on the two sides of the field.
6. Put some clean water into the sprayer tank.
7. Determine the water volume in the tank with the calibration stick.
8. Mount the sprayer and spray the water along the garden lines representing the crop rows.
9. Maintain constant sprayer pressure and walking speed until the area is covered.
10. Dismount the sprayer and dip the calibration stick to determine the volume of water used to cover 100 m^2
11. Repeat the process at least two times and find the average volume of water used.
12. Extrapolate to the volume of water ha-1 using the relation:

$$[\text{Ha } (m^2)/\text{area treated } (m^2)] \text{ x (vol. of water used to spray the treated area} = (10{,}000 m^2/100 m^2) \text{ x V}$$

The quantity of pesticide needed per hectare

1. Most manufacturers indicate the amount of active ingredient (AI) per litre of the formulated product on the container, e.g. 40 EC
2. If you know the amount of AI to apply per ha, then vol. of product needed per hectare = [Wt. (g) of AI ha^{-1}/conc. (%) AI in product] x 100
3. If the AI to cover 1 ha = 200 g, and the chemical is formulated as 40 EC (i.e. 40 % vol), then the volume of chemical needed per ha

   = (Wt. (g) of AI ha^{-1} / Conc. (%) AI in product) x 100 mL

   = 200/40 x 100 mL

   = **500 ml of chemical required to cover 1 ha of crop**.
4. From this, the amount of the chemical needed per litre of water can be calculated.

Basic precautions when applying pesticides

1. Avoid spraying during peak flowering to encourage pollinators; otherwise, use selective pesticides which are not harmful to insect pollinators.
2. Keep the sprayer nozzle 30-40 cm above the crop canopy for good coverage.
3. Keep sprayer pressure high throughout spraying.
4. Replace respirator and sprayer filters regularly.
5. Respirator filters must be changed if one can smell pesticide through them while spraying.

Activity 4.2: Identifying farm machinery safety precautions

In pairs, identify precautions taken when operating farm machines and discuss the need to take precautions when operating farm machines. Write down relevant notes and share your findings with other classmates.

Steps to follow:

1. With your partner, list and discuss the precautions you think are necessary when operating farm machinery. You could consider factors such as wearing protective gear, following operation manuals, and performing regular maintenance.
2. Surf the Internet and watch videos or view pictures that show examples of safe farm machinery operations. Pay close attention to how operators handle machinery safely and identify any safety measures they use. Ensure you add any new precautions you observe to your list.
3. Discuss with your partner why each precaution is important, considering how these measures protect operators, prevent accidents, and extend the life of machinery, and think about the potential risks of ignoring safety guidelines.
4. Summarise your group's ideas by creating a list of safety tips with explanations for each important step identified and share your findings with the class.

Activity 4.3: Calibration and use of knapsack sprayer

With the same partner, practice the calibration, use and maintenance of the knapsack sprayer. Make sure you identify an area of open land or a playing field to allow you to use a knapsack sprayer. Share your experience with your classmates.

Follow the steps below to achieve **Activity 4.3:**

Option A: Download and watch video tutorials

1. With the same partner, surf the Internet and watch videos on calibration, operation and maintenance of a knapsack sprayer. Pay attention to key steps such as calibration, safety measures, and proper handling techniques demonstrated in the videos.
2. Discuss with your partner the main points from the videos, including calibration, operation steps, maintenance techniques, and highlighted precautions, and consider why each safety measure is important.
3. Get a knapsack sprayer and practice calibrating and operating the knapsack sprayer with your partner, taking turns to follow the steps demonstrated in the video while maintaining a steady spray pattern and correct handling.

Ensure your partner adheres to safety protocols, including wearing protective gear as shown.

4. Review and discuss the maintenance techniques presented in the video, including cleaning the sprayer, checking for wear, and safely storing it after use. Ensure that your partner actively participates in identifying these maintenance steps and understands their importance in keeping the equipment in good condition.
5. Summarise the operation and maintenance steps from the videos by creating a quick reference guide. Include safety tips and troubleshooting solutions for any common problems highlighted in the videos and share your experience with the large class.

Option B: Visit to local farms

1. Visit a large-scale farm (where available) to observe a demonstration on the proper use and maintenance of the knapsack sprayer.
2. Learn and practice how to calibrate and operate the knapsack sprayer, taking turns and focusing on maintaining a steady spray pattern and proper handling techniques.
3. Again, practise and discuss the maintenance techniques being observed as demonstrated by the operator. Discuss the importance of cleaning the sprayer, checking for wear, and safely storing it after use, while ensuring that your partner contributes to identifying these steps and understands their significance for maintaining the equipment in good working condition.
4. Summarise the operation and maintenance steps from the demonstration by discussing your experiences, any challenges you faced during the operation, and insights gained about the maintenance of farm machinery with your group members.

REVIEW QUESTIONS

1. State the various types of machinery used in planting, harvesting and postharvest activities in the production of maize.
2. Discuss the role of combine harvesters in cereal production in Ghana.
3. Explain three precautions employed during the operation of a farm machine.
4. Outline the calibration of a knapsack sprayer.

SECTION

5 PRODUCING CROPS FOR INCOME

Farming for Jobs and Incomes

Agricultural Machinery

INTRODUCTION

Hello learner, you are welcome to section 5 of year two of Agricultural Science. This section introduces you to how you can produce arable crops for jobs and incomes. In this section, you will discover what arable crops are, how to conduct market needs and assessment for arable crops, the pre-planting and post-planting activities to be carried out, the harvesting methods and post-harvesting operations to be done, and the marketing of arable crops: The section is to help you appreciate and practise crop production for consumption and profit.

KEY IDEAS

- Arable crops: These are usually annual crops grown on land that is suitable for cultivation, which typically require fertile soils with adequate tillage, water and suitable climate conditions. Examples of arable crops include grains, pulses, root crops, and oil seeds.
- Harvesting and post-harvesting operations: These involve the harvesting of the arable crops and all other activities that are carried out before the harvested crops get to the final consumer.
- Market needs and assessment: This is the first step in producing arable crops with the intention of making a profit. It involves ascertaining what consumers need and evaluating all the various factors influencing the demand, supply and the overall market dynamics.
- Marketing arable crops: Marketing involves strategies that focus on the promotion and sales of harvested arable crops.
- Planting and post-planting activities: These involve the actual planting and all the other activities that are carried out in the field before harvesting is done. These are sometimes called cultural practices.
- Pre-planting activities: These involve all activities that are carried out before arable crops are eventually planted in the field.

MARKET NEEDS FOR ARABLE CROP PRODUCE

Determination of Market Needs for Arable Crop Production

Conducting a market assessment for arable crops involves evaluating various factors that influence the demand, supply, and overall market dynamics. The market needs and assessment should be a very comprehensive evaluation to identify the market, opportunities, and planning for future production. The detailed guide to performing a market assessment for arable crop production includes:

1. Market demand: This involves identifying the demand for specific crops, including volume, quality and timing. This will help farmers to produce the required quantities for profit.
2. Consumer preferences: It is always important that farmers should understand consumer preferences for sustainable production, e.g. organic, non-GMO and specialty crops. Without assessing the consumers' preferences, one may produce a particular arable crop where there may not be any ready market for it. Assessing consumers' preferences is therefore a basis for continuous and sustainable production.
3. Industry requirements: Producers also need to know the raw material needs of industries such as food processing, animal feed and biofuels. Assessing the industry needs also helps farmers to target their production to avoid waste, storage challenges and more importantly, to increase income and profits.
4. Market trends: It is also important as part of the market needs and assessment to analyse market trends to identify changes in consumer behaviour, technological advancements, and environmental concerns.
5. Competitor analysis: Assessment should not only be limited to the needs and preferences of consumers and their behaviour, but should also include assessing the competition in the market. Competitor assessment should include assessing one's strengths, weaknesses and market share. This will enable farmers to identify the gaps in the market and strategically produce in order to be highly competitive.
6. Price analysis: It is very important to determine the market price for specific crops. Again, it is equally important to analyse price fluctuations and trends in the market. This will help farmers to adjust their prices and also produce strategically to be highly competitive.
7. Supply analysis: It is also equally important to evaluate the current production levels of various arable crops. This analysis should study historical data to identify trends in production volumes. This supply analysis can help to maintain a constant supply flow in order to maximise profit.
8. Supply chain efficiency: Analysing the market needs should also include evaluating the efficiency of the supply chain. This should include, but not

be limited to, logistics, transportation, and storage. This helps producers to determine whether demands can be met from nearby production centres.

9. Regulatory environment: It is also important to consider government policies, regulations, and subsidies that impact arable crop production and trade. This enables farmers to make informed decisions about their production.
10. Market information system: Analysing market trends, consumer behaviour, and supply chain efficiency helps farmers to make informed decisions on what to plant and when to sell. When this market information analysis is properly done, it helps to produce efficiently in order to maximise profit.
11. Profit margins: It is important to determine the profitability of arable crop production based on current market prices and production costs. If, after profit margin analysis, the profit level is low, then there is no need to initiate the production processes in the first place. The opposite is also true.

Challenges Associated With Marketing Arable Crops In Ghana

In Ghana, the marketing of arable crops faces several challenges. These can result from infrastructure, economic and social factors, policy and regulatory issues and environmental factors. Here are some of the key challenges:

1. Poor transportation networks: The roads in many rural areas in Ghana are in a very poor state. This makes it very difficult to transport crops easily to markets. This causes delays, increased transportation costs, and ultimately results in increased crop spoilage.
2. Inadequate storage facilities: Many storage facilities in the crop-producing areas have broken down, with the few that are serviceable far from each other. This results in high post-harvest losses. Many farmers cannot afford modern storage facilities, and as a result, they are compelled to sell their produce at cheaper prices, usually at the farm gate, to avoid spoilage and waste.
3. Inadequate financial support: Small-scale farmers in Ghana often struggle to obtain the credit needed to invest in inputs, processing and storage facilities. This limits their productivity and competitiveness.
4. Price fluctuations: In Ghana, crop prices change a lot. This price volatility is influenced by weather conditions, market trends and local supply and demand dynamics. These sharp price changes ultimately affect farmers' profit margins, and this results in a decrease in interest in farming.
5. Inconsistent policies: The nation does not appear to have consistent agricultural and farming policies. These frequent changes in agricultural policies tend to create uncertainties and hinder long-term planning. The inconsistent policies on subsidies, tariffs, and import/export regulations negatively affect market stability.

6. Limited market information: Farmers often have limited access to timely and accurate market information. This limited market information affects their ability to make decisions about what to grow and when to sell.
7. Middlemen dominance: In Ghana, there are so many middlemen in the sale of farm produce. There is what is termed as middleman dominance. They buy farm produce at the farm gate at a very low price and sell it at exorbitant prices, not to the final consumers but rather to other individuals.
8. At each level, some margin of profit is added. The presence of these middlemen erodes farmers' profits, as they often control the market and take a significant share of the earnings.
9. Low adoption of technology: Limited access to modern farming techniques and technologies reduces productivity and quality. Many farmers rely on traditional methods due to a lack of training and resources. This affects productivity and quality of their produce, leading to marketing difficulties, especially in accessing the international market.
10. Poor pest and disease management: There are inadequate pest and disease control measures. This leads to significant crop losses, thereby reducing the quality and quantity of produce available for marketing.
11. Global market pressures: West African farmers often face stiff competition from imported goods, which are usually cheaper due to subsidies and more advanced farming techniques used in other countries.

Marketing Strategies to Improve Arable Crop Marketing in Ghana

Increasing farmers' profits through effective marketing strategies for arable crops in Africa involves several key approaches:

1. Market diversification: Farmers should endeavour to reach various markets with their produce – local, regional, and international markets. This is what is termed market diversification. Diversifying one's market base helps to sell in different markets. This helps farmers to make more profits.
2. Value addition: One strategy to improve the marketing of arable crops is to add value to the farm produce. Investing in processing facilities helps to convert raw crops into higher-value products. For example, milling maize into flour, processing soya beans into oil, or converting cassava into gari. This improves farmers' access to markets, thereby increasing their profit margins.
3. Branding: Branding farm produce makes it more appealing to the consumer. Developing strong brands for arable crops enhances product market appeal. Branding includes packaging, unique selling propositions indicating quality, organic production, or fair-trade practices.
4. Cooperative marketing: Cooperative marketing involves a group of farmers jointly selling similar farm produce to achieve better prices, reduce costs, and gain bargaining power in the marketplace. Farmer groups can pool resources

together to increase bargaining power and access larger markets. Cooperative marketing, therefore, helps to reduce or eliminate unnecessary competition for the sale of the same farm produce from different farmers.

5. Direct marketing: Another strategy to improve the marketing of arable crops and to maximise profit is to engage in direct marketing of farm produce to consumers. With this strategy, producers sell directly to consumers, cutting out middlemen and retaining more profit. Farmers can also achieve this through digital platforms and e-commerce to reach a wider audience and sell directly to consumers. Mobile technology helps disseminate market information and enhance transactions.
6. Quality improvement: Quality improvement and assurance are also good strategies to improve the sales of arable crops. Resorting to the best agronomic practices, post-harvest handling, and quality control ensures that produce meets market standards. Producing wholesome produce at all times creates consumer reliability and patronage. This increases profits for producers and farmers.
7. Market information system: Systems that provide farmers with real-time market information on prices, demand, and supply trends enable farmers to get maximum profit. The use of the media and new technologies can be deployed to access real-time market information to enhance the marketing production of arable crops.
8. Financial services: Farmers who access affordable credit and microfinance invest in better inputs and technology. The government can also formulate policies that support smallholder farmers, such as subsidies for inputs, price guarantees, and investment in rural infrastructure. Agricultural insurance for products to protect farmers against risks such as crop failure, pests, and extreme weather will also help farmers benefit from their investment.
9. Marketing campaigns: Farmers should conduct awareness campaigns to educate consumers about the benefits of locally produced crops. This should include promotional events such as food fairs, exhibitions and conducting sensory (taste) tests to showcase products and attract buyers.
10. Private sector partnerships: Farmers should partner with private sector companies for investment, technology transfer and market access. Farmers can also collaborate with NGOs and other development agencies for capacity building, funding and technical assistance to enhance production and the marketing of their produce.

Activity 5.1: Market needs for arable crop production

Identify market needs for arable crop production through a visit to the community and local markets.

Follow the steps below to achieve **Activity 5.1:**

1. In small groups, surf the Internet for information on how to assess the market needs of consumers for farm produce. Discuss and write down the key criteria for assessing the market needs of consumers for the production of arable crops.
2. Visit the community or local market to check for the types of arable crops being sold.
3. Find out from the consumers the following information: market demands, consumer preferences, industry requirements, and market trends.
4. Identify the key suppliers and the producers of those arable crops so you can identify any supply gaps.
5. Determine the production and marketing gaps that exist in those markets and analyse the reasons why those gaps exist. Write down relevant notes.

Activity 5.2: Challenges faced in marketing arable crops

With the same group, discuss the challenges faced in marketing arable crops in Ghana and analyse strategies that can be adopted to market arable crops and thus improve farmers' profit margins.

Follow these steps to finish **Activity 5.2:**

1. Discuss the challenges faced in the marketing of arable crops and write down the key points.
2. Also discuss the strategies that can be adopted to market arable crops.
3. Surf the Internet for more information on the challenges faced in the marketing of arable crops.
4. Discuss and analyse the key points from the additional information that are applicable in the local market environment.
5. Discuss those measures that could be adopted by farmers to properly market their farm produce in order to maximise profit. Write down relevant notes

PRODUCTION OF SELECTED ARABLE CROPS

Pre-planting Activities

In arable crop production, well-planned and well-executed pre-planting activities create optimal conditions for seeds to germinate, emerge, establish, grow and produce crops. These activities ensure that the soil is well prepared, nutrients are available, and potential problems are identified and mitigated before planting. The key pre-planting activities are:

Site selection and soil testing

To select a site for arable production, the following factors should be considered:

a. Soil type and quality: Soil type and quality directly affect crop growth and yield.
   i. **The soil qualities to consider are:**
   ii. **Soil texture:** The soil texture consists of clay, loam and silt. Loamy soils are generally preferred as they have good drainage and nutrient-holding capacity.
   iii. **Soil fertility:** The fertility of a soil ensures that the soil has adequate essential nutrients.
   iv. **pH levels:** Most crops grow best in soils of neutral pH (6.0-7.5), but specific crops have different pH requirements.
   v. **Drainage:** A soil with very good drainage supports arable crop production. Well-drained soils prevent waterlogging, which damages crops.

b. Water availability: Reliable water sources are essential for irrigation. In selecting a site for arable crop production, it is important to consider the following:
   i. **Proximity to water sources:** Nearness to a water source like rivers, dams, ponds, or provision of wells and harvested water stored in tanks, ensures easy access to water for irrigation purposes.
   ii. **Water quality:** The water to be used for irrigation should be free from contaminants such as toxic chemicals, pathogens, and heavy metal salts and must be suitable for irrigation.
   iii. **Irrigation infrastructure:** The type, availability and condition of irrigation systems must be considered.

c. Climate and weather conditions: The climate of the area should be suitable for the chosen crops. The following factors play key roles in considering climate suitability for the selected crops:
   i. **Temperature:** The temperature range of the area selected should be appropriate for the chosen crops.
   ii. **Rainfall:** Adequate and well-distributed rainfall is very crucial for all arable crop production. It is very important to consider an alternative for irrigation in areas with or climate where rainfall is insufficient or not fairly distributed.
   iii. **Wind:** Very high winds can cause soil erosion and damage to crops.

d. Topography: The physical layout or the topography of the land affects water runoff and soil erosion. The topography of an area can be described as flat, gentle slopes, hilly, undulating or mountainous. It is therefore very important that the slope and elevation of the selected land area be considered for the cultivation of any arable crops
   i. **Slope:** Flat and gentle slope sites are preferred for the cultivation of arable crops to prevent erosion and facilitate the use of machinery.

ii. **Elevation:** Higher elevations might have cooler temperatures and different microclimates, and therefore are only suitable for certain crops.

e. Proximity to markets and other storage infrastructure: Proximity to markets and other storage infrastructure reduces transportation costs and facilitates market access. It is important to consider the following:

   i. **Distance to markets:** The closer the market, the less the transportation costs and time.

   ii. **Availability of storage facilities and infrastructure:** Proper storage facilities help preserve the quality of the farm produce.

f. Farm accessibility: The site selected for arable crop production should have good road networks to facilitate faster and easier movement of machinery and farm produce.

g. Labour availability: An adequate workforce is needed for various farming operations. It is very important to consider the following:

   i. **Local workforce:** Availability of skilled and unskilled labour in the vicinity or the community where the farming enterprise is to take place.

   ii. **Cost of labour:** Considering labour availability and costs ensures that labour costs are within budget.

Soil testing

To determine soil fertility status, the following steps are followed:

a. Collect soil samples from different parts of the field.

b. Put all samples together (composite) and mix them thoroughly.

c. Fetch 3 or 4 sub-samples and send them to a laboratory for texture, organic matter, pH and nutrient level analysis.

d. Interpret results to guide soil amendment decisions.

Selection of Crop Variety

Selecting the appropriate crop variety for production can significantly impact yield, pest and disease resistance and overall farm profitability. The key factors to consider when choosing a crop variety include:

1. Climate and weather conditions: Crop varieties have specific temperature, rainfall, and humidity requirements. It is always important to choose varieties of crops that can withstand the local conditions including extreme temperatures and wind conditions.

2. Soil type and fertility: Crops have different soil preferences and nutrient needs. Therefore, it is important to select crops and varieties that match the soil type and fertility status or that can thrive with the available fertilisers.

3. Availability and seed quality: High-quality seeds are essential for good germination and vigorous growth. It is important to ensure that seeds are

selected from reputable suppliers and check germination rate and seed health before planting.

4. Cost and economic viability: The chosen variety should be cost-effective and economically viable. Consider the cost of seeds and associated technology fees (e.g. for genetically modified varieties). Calculate potential returns considering the cost of production and expected market prices.
5. Pest and disease resistance: It is very important to choose crop varieties that are resistant to common pests and diseases in the area to reduce losses and ensure high yields.
6. Maturity period: In selecting a crop variety it is important to ensure that the variety's growth cycle fits within the local growing season. Select early-maturing varieties to avoid reproductive phase drought or if planning multiple cropping.
7. Yield potential: Higher-yielding varieties can increase farm profitability. Choose varieties with proven large yields under similar conditions. Select varieties that consistently perform well across different environmental conditions.
8. Market demand and quality: Choose varieties that meet local or export market requirements for size, colour, taste and other quality attributes. Meeting market preferences ensures better prices and profitability.
9. Government support policies and programmes: Take advantage of strategic government programmes that support certain crops. For example, the crops under the Planting for Food and Jobs may offer special incentives.

Seed Treatment

Seeds selected must be protected from pests and diseases to enhance germination.

1. Treat seeds with fungicides, insecticides, or bio-control agents such as the bacteria *Bacillus* and *Pseudomonas spp.* and the fungus *Trichoderma spp*.
2. All seeds coated with synthetic pesticides must be handled with care.

Seed Germination Test

A germination test is a necessary step in determining the viability of seeds before planting. It ensures that only seeds with a high germination ability are sown. This lays a better foundation for a successful crop growth and yield. Here is a guide to conducting a germination test and recording the percentage of germination:

1. **Materials needed for a germination test**
    a. Seeds to be tested
    b. Paper towels or filter paper
    c. Water
    d. Plastic bags or containers
    e. Labels
    f. Pen and notebook

2. **Steps**

   a. **Seed sample:** Randomly select a sample of seeds from the batch to be tested. A common sample size is 100 seeds, but a smaller number can be used.

   b. **Set-up preparation:**

      i. Moisten paper towels or filter papers. They should be damp but not soaking wet. Place the moistened paper towels in a container or lay them flat on a clean surface.

      ii. Spread the seeds evenly on the moistened paper towels. Make sure they are not touching each other. If using multiple samples, label each sample clearly.

      iii. Place another layer of moist paper towel over the seeds. If using a container, cover it with a lid or plastic wrap to retain moisture. If using plastic bags, seal them loosely to allow some air circulation.

   c. **Incubation:** Place the set-up in a warm, dark place. The optimal temperature for most tropical seeds is between 25 and 30°C. Check the seeds daily to ensure the paper towels remain moist. Add water if necessary.

   d. **Counting germinated seeds:** After a set period (usually 7-14 days, depending on the seed type), count the germinated seeds. A seed is considered germinated if it has developed a radicle (the first root).

3. Determining percentage germination

   a. **Total germinated seeds:** Count the seeds that have successfully germinated out of the total number tested.

   b. **Percentage germination:**

      Use the formula: Percentage germination = () × 100.

   c. **For example:** If 200 seeds were tested and 180 of them germinated, then:

      Percentage Germination = (180/200) × 100 = 90 %

   d. **Recording results:** Create a record of your germination test results in a notebook or spreadsheet. Include the following information:

      i. Date of the test.

      ii. Seed type and batch number.

      iii. Total number of seeds tested.

      iv. Number of seeds germinated.

      v. Percentage germination.

      vi. Observations (e.g. any abnormalities in seedling growth)

Land Preparation for Arable Crop Production

Land preparation ensures optimal soil physical conditions for planting and crop growth. Proper land preparation helps improve soil structure, manages weeds and enhances germination and crop yields. The key steps involved in land preparation are:

1. Land clearing: This involves the removal of vegetation cover on the land and the removal of debris, stones, and other obstacles. Use manual tools (like machetes and hoes) or mechanical equipment (like tractors and bulldozers) for clearing the land.
2. Tillage: Soil tillage refers to the mechanical cultivation of the soil to prepare it for planting. The tillage processes involve:
    a. Primary tillage: This involves deep ploughing or digging to break up the soil pan and incorporate organic matter into the soil. It helps in improving soil aeration, water infiltration and weed control. Ploughing is done using mouldboard ploughs, disc ploughs, or chisel ploughs to turn over the soil.
    b. Secondary tillage: This follows primary tillage to refine the soil, break clods, and prepare a fine seedbed for planting. This can be done through harrowing or rotary tilling.
        i. Harrowing: Using disc harrows or tine harrows to break soil clods.
        ii. Rotary tilling: Using rototillers to achieve a fine tilth.
3. Levelling
    a. A level field ensures uniform water distribution and easier irrigation and drainage.
    b. Use land planes or equipment for levelling large fields or manual levelling tools for smaller plots.
4. Ridging and mounding: Ridges and mounds are used in agriculture to improve crop growth.
    a. **Ridge formation:** Ridges are typically formed using a ridge plough or specialised cultivator that lifts and forms the soil into raised rows. Cereals like maize (corn) and millet can be sown on ridges to manage water efficiently and reduce soil compaction and erosion. Root crops like sweet potato, cassava and seed yam can be planted on ridges due to the loose, well-drained soil that promotes root and tuber development.
    b. **Mound formation:** Mounds are typically formed manually with hoes or mechanically with specialised equipment that heap the soil into conical shapes for planting. Common arable crops planted on mounds include yam, cassava, potato, groundnut, and Bambara groundnut.

Lining and Pegging for Planting

Lining and pegging for planting arable crops ensures planting in an orderly manner. Lining ensures rows and spacing are accurate before planting. This step maximises

space utilisation, ensuring proper plant growth, and facilitating subsequent farm operations like weeding, irrigation, and harvesting.

a. **Steps in lining and pegging:**
   i. Field measurement: Measure the field to determine the planting area.
   ii. Establishing baselines: Identify the base of the field, i.e. the side from which planting should start. Stretch a garden line along the base.
   iii. The use of 6-8-10 (Pythagoras' theorem) ensures a straight baseline.

b. Marking rows:
   i. Mark the inter-row spacing based on the crop's requirements, e.g. 80 cm for maize and 60 - 75 cm for cowpeas.
   ii. Stretch a garden line and tape along the field base to mark the desired row spaces.
   iii. Fix pegs at **the marked points.**

c. Benefits of lining and pegging:
   i. Optimal space utilisation: Line and pegging ensure plants have enough space to grow without competition for resources.
   ii. Facilitates farm operations: It makes agronomic practices (weeding, pest monitoring, fertiliser and pesticide application and harvesting) easier and more efficient.
   iii. Aesthetic appeal: Proper lining and pegging result in a neat and organised field layout.

Methods of Sowing Seeds or Transplanting Seedlings

Arable crop seeds are sown in different ways and with different equipment depending on crop type, field condition and farm management practices. Here are some common methods of sowing arable crop seeds.

1. **Dibbling:** This is a method of planting seeds directly into the soil by placing them at specific intervals and depths, often using a pointed stick, hand tool, or mechanised equipment. Seeds are manually placed in small holes made with different implements, including hoes, sticks/dibbers and cutlasses, and covered. This is done without attention to spacing and seed depth in the soil.

Advantage	Disadvantage
Suitable for large seeds like beans and maize.	Labour-intensive and slow.
Reduces wastage of seeds, fertilisers, and water by targeting specific planting spots.	Not suitable for large-scale planting.
Ensures uniform spacing of seeds, leading to optimal plant growth and yield.	

2. **Broadcast sowing:** Seeds are scattered over the soil surface either manually or by a mechanical broadcaster evenly. The field is then harrowed to cover the seeds with soil.

Advantages	Disadvantages
The method is simple and quick.	Uneven seed distribution can occur.
Suitable for small seeds and crops like grass and legumes.	Requires an additional operation, like harrowing, to cover seeds with soil.
Large fields can be sown in a relatively short time.	Higher seed rate required due to potential wastage.

3. **Row planting:** Seeds are planted in rows with specific spacing between and within rows. The precision of the planting distances (inter-row and intra-row) and seed depths varies widely according to the planting device and equipment
4. **Manual row planting:** Seeds are sown with sticks, cutlasses and hoes. Seed depth is highly variable, resulting in uneven seedling emergence.

Advantages	Disadvantages
Allows for easy mechanised cultivation and harvesting.	More labour-intensive if done manually.
Ensures optimal plant population and resource use.	Requires careful planning and execution.

5. **Drill sowing:** This is a form of precision planting where seeds are sown in evenly spaced rows at a specified depth, using a seed drill. Examples of seeds that can be drill-sown include cabbage, rice, eggplants and cowpeas.

Advantages	Disadvantages
Precise seed spacing and depth.	Requires a costly seed drill.
Efficient use of seeds with lower seed rates.	Not suitable for small or uneven fields.
Facilitates mechanised weeding.	
Easier field operations.	

6. **Precision sowing:** Seeds are planted at exact intervals and depths using precision seeders.

Advantages	Disadvantages
Maximises seed use efficiency and ensures uniform plant spacing.	Requires sophisticated and expensive equipment.

Ideal for high-value crops where precision is critical.	May require skilled labour for operation.

7. **Transplanting:** Seedlings are raised in a controlled environment and later transplanted to the field.

Advantages	Disadvantages
Only healthy seedlings are transplanted.	Labour-intensive and time-consuming.
Good establishment, optimum crop density and vigorous growth of seedlings.	Requires additional infrastructure like nurseries or greenhouses.
Allows for better crop timing and season extension.	

Seedling Emergence Assessment

Many seeds germinate but fail to emerge from the soil. A seedling emergence test measures the ability of seedlings to emerge and establish as seedlings under field conditions. Here's a guide on how to determine percentage emergence:

a. Note the number of seeds sown.

b. Count the seedlings emerged and note the number.

c. Calculate the percentage emergence thus:

Percentage emergence = (No. of seedlings emerged/No. of seeds sown) × 100

Note: Record all observations (e.g. any issues with soil conditions or seedling health) during the test.

Factors that influence seedling emergence from the soil

1. **Seed quality and viability:** Seedling emergence depends on the viability and quality of the seed.
2. Soil moisture: Adequate soil moisture is essential for seed germination and emergence. Germination and emergence may fail in soggy soil.
3. Soil temperature: Optimal soil temperature for seed germination and emergence varies with the crop and the variety.
4. Soil texture and structure: Well-draining, loose soil improves seedling emergence.
5. Planting depth: Seeds planted too deep may exhaust their energy reserves before reaching the surface.
6. Soil compaction: Compacted soil hinders seedling emergence.
7. Soil salinity and pH: Extreme soil salinity and pH delay or prevent seedling emergence.

8. Plant residue and mulch: Excessive plant residue or mulch impedes seedling emergence.
9. Pests and diseases: Pests and diseases damage seeds and seedlings, reducing emergence.
10. Planting time: Planting at the optimal time for the specific crop and region can improve emergence.

Activity 5.3: Planting of an arable crop

Find friends in your class and select an arable crop of your choice to grow and identify the pre-planting and planting activities performed when cultivating the selected arable crop. Again, carry out germination tests and record percentage germination and percentage emergence.

Follow the steps below to achieve **Activity 5.3**

Option A: For schools that have suitable land for on-field cultivation.

Steps:

1. Form a group of four students.
2. With the help of the teacher or facilitator, secure a piece of land or school plot.
3. Undertake all the pre-planting and planting operations on the land and list them down. This may include clearing of the land, ploughing or tillage, lining and pegging, levelling, ridging and moulding, etc. NB: The type of pre-planting activities to be done depends on the type of crops selected for planting.
4. Undertake a seed germination test in your classroom and calculate the rate of seed germination.
5. Once your seeds have been sown in the school plot, determine the percentage of seedling emergence.
6. Discuss the experimental results of the germination test and seedling emergence assessment and present your results to the class.

OR

Option B: For schools that do not have suitable land for on-field cultivation.

Grow a selected arable crop of your choice in your school premises or at home using a containerised system. The steps below will guide you on how to grow an arable crop using a containerised system at your school premises or at home.

Materials needed: Empty milk or milo tins, plastic containers, used lorry tyres horizontally placed, or sacs, fertile soil, water and a viable arable crop (such as legumes, soyabeans, potatoes, etc.) and some method of shading seedlings.

Steps:

1. Fill the containers, or the sacs, or the horizontally placed used lorry tyres with the soil, preferably a loamy soil or any other substrate.
2. If metal or plastic containers are to be used, smaller holes must be created in them before they are filled with soil. These "drainage holes" allow excess water to drain.
3. Fill the containers with the appropriate soil type.
4. Sow some seeds of the selected arable crops in the soil-filled containers or the sacs.
5. Water the soil immediately after sowing the seeds of the arable crop.
6. Place the container with the sown seeds under very good shade or an appropriate environment.
7. Take note of all the pre-planting and planting operations on the land and list them down.
8. Undertake a seed germination test and calculate the rate of seed germination.
9. Once your seeds have been sown, determine the percentage of seedling emergence.
10. Discuss the experimental results of the germination test and seedling emergence assessment and present your results to the class.

Well done! I hope you found this practical activity very interesting.

PRODUCTION OF A SELECTED ARABLE CROP

Post-Planting Activities/Cultural Practices/Crop Management Practices

Post-planting cultural practices ensure crops receive the necessary care throughout their growth. Key post-planting activities include;

Weed control

Effective weed control is essential for achieving large yields and quality produce in arable crop production. Weeds compete with crops for resources such as light, water and nutrients, and can harbour pests and diseases. The methods used to control weeds include:

a. Cultural control:

   i. **Crop rotation:** Rotating crops with different growth habits and planting times can break the life cycle of weeds.

ii. **Cover crops:** Growing cover crops can suppress weeds by shading the soil and outcompeting weeds for resources.

iii. **Mulching:** Applying organic or synthetic mulch can prevent weed germination by blocking light.

iv. **Planting density and timing:** Crops grown at the recommended spacing (density) close their canopy sooner, hence get a competitive advantage over weeds.

b. Mechanical control:

i. **Tillage:** Ploughing, harrowing and cultivating can physically remove or bury weeds. However, it can also bring weed seeds to the surface.

ii. **Mowing and slashing:** Regular mowing or slashing can prevent weeds from flowering and setting seed, and with time, reduce the weed seed load in the soil.

iii. **Hand pulling:** Manual removal of weeds, particularly in small fields or gardens.

c. Chemical control:

i. **Herbicide use:** Using selective and non-selective herbicides to control weeds is a common practice. However, it is important to rotate herbicides with different modes of action to prevent the development of resistance.

- Selective herbicide: Atrazine kills all broad-leaved plants but not grasses, hence used as a post-emergence herbicide in maize. 2,4-D kills all broad-leaf weeds in cereals, particularly in rice.
- Non-selective herbicide: Paraquat kills all plants.

ii. **Pre-emergence herbicides:** Applied before the weed seeds emerge to inhibit seedling growth, e.g. Atrazine

iii. **Post-emergence herbicides:** Applied to kill actively growing weeds before planting or within the crop, e.g. Glyphosate.

d. Biological control:

i. **Biocontrol agents:** Using natural enemies such as insects, pathogens, or grazing animals to suppress weed populations. For example, Acheampong weed is controlled by the larvae of a moth (Pareuchaetes pseudoinsulata).

ii. **Allelopathy:** Growing plants that release natural chemicals to inhibit weed germination and growth, e.g. cowpeas inhibit Striga hermontica while cereals like maize and rice inhibit Striga gesnerioides.

Irrigation/watering

This is the process of supplying adequate water through various methods such as drip irrigation, sprinkler systems, or traditional flooding, depending on the crop and local conditions. The benefits of irrigation in arable crop production are:

a. Supplementing rainfall: In regions with insufficient or irregular rainfall, irrigation supplies the necessary water for proper crop growth and development.

b. Optimising nutrient uptake: Water is essential for the dissolution and uptake of soil nutrients by plant roots.

c. Mitigating the effects of drought: During periods of drought, irrigation can provide the necessary water to sustain crops, preventing total crop failure and ensuring food security.

d. Extending growing seasons: Irrigation allows farmers to grow crops during dry seasons or in areas with limited rainfall, thereby extending the growing season and increasing the number of crops produced annually.

e. Preventing soil salinisation: In areas prone to soil salinity, irrigation helps leach excess salts from the root zone, maintaining soil health and crop productivity.

f. Enhancing crop yield: Water supply through irrigation ensures consistent and adequate soil moisture for optimal plant growth and yield.

Soil fertility enhancement

Soil fertility status determines the vigour, health and yield of the crop. Soil fertility improvement is done mostly through the application of various fertilisers.

a. Types of fertilisers:

   i. **Organic fertilisers:** Derived from natural sources such as compost, manure, bone meal and green manure. They release nutrients slowly and their bulk improves soil structure, water retention and microbial activity.

   ii. **Inorganic (synthetic) fertilisers:** Manufactured in granular and liquid forms through chemical processes and provide nutrients in readily available forms. They can be constituted to supply specific nutrient ratios (N-P-K).

b. Methods of fertiliser application: Proper fertiliser placement promotes healthy growth and development.

   i. **Broadcasting:** It involves spreading fertilisers evenly across the entire field surface. Suitable for pre-planting applications or top-dressing established crops. This can be done manually or using mechanical fertiliser spreaders.

   ii. **Banding:** This involves placing fertilisers in concentric bands near the crop or root zone. This method of fertiliser application improves nutrient uptake efficiency and reduces nutrient loss.

   iii. **Foliar application:** Spraying liquid fertilisers directly onto plant leaves to ensure quick nutrient uptake, especially micronutrients.

   iv. **Side-dressing:** It involves applying fertilisers along the sides of growing plants. It is commonly used for nitrogen application in row cropping systems and with crops like maize.

   v. **Fertigation:** It is the application of liquid fertilisers through irrigation systems. Ensures even distribution of nutrients with water.

c. Plant nutrients: Plants require several essential nutrients for growth, which are classified as macronutrients and micronutrients

   i. **Macronutrients:** Also grouped into primary and secondary nutrients.

      - Primary macronutrients: These are needed in large quantities, e.g. nitrogen (N), phosphorus (P), and potassium (K).
      - Secondary macronutrients: calcium (Ca), magnesium (Mg) and sulphur (S).

   ii. **Micronutrients:** These are required in small amounts, but plants quickly show deficiency symptoms when they are not available because they play important roles in plant physiology as they play important roles in plant physiology. Examples are iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), molybdenum (Mo), boron (B) and chlorine (Cl).

Thinning

It is the practice of removing excess seedlings per crop stand to reduce intraspecific competition and ensure optimal spacing for healthy growth. The benefits of thinning include:

a. Reduces competition: It helps reduce competition for nutrients, ensuring that each remaining plant receives an adequate supply for optimal growth.

b. Disease prevention: It promotes better air flow around the plants, reducing the risk of fungal and bacterial diseases, particularly in seedlings, which thrive in humid conditions.

c. Sunlight exposure: This allows more sunlight to reach each plant, enhancing photosynthesis and overall plant vigour.

d. Larger and healthier plants: Thinning promotes more robust plants, increasing productivity.

e. Uniform crop stand: This results in a more uniform crop stand, which is easier to manage and harvest

Pruning and training

Removing unwanted parts of plants (e.g. side shoots, dead branches) to direct energy towards desired growth. Also, training allows plants to grow in specific shapes or directions for better sunlight exposure and air circulation. The benefits of pruning and training include:

a. Enhanced light penetration: Pruning allows more sunlight to reach the inner and lower parts of the plant, ensuring that all parts of the plant can photosynthesise effectively.

b. Improved aeration: Removing excess foliage enhances air flow around the plants, reducing the risk of fungal diseases and promoting healthier growth.

c. Reduced competition: Pruning crowded branches reduces competition for water, nutrients and light, leading to more robust plant growth.

d. Growth stimulation: Pruning can stimulate new growth and encourage the development of more productive branches or stems.

e. Disease and pest control: Pruning removes diseased or pest-infested parts of the plant, thereby preventing the spread of diseases and pests.

f. Increased yield and quality: By removing unproductive or damaged parts, the plant can direct more energy and nutrients to the remaining healthy parts, resulting in better yield and higher-quality produce.

Staking and support

These are acts of supporting tall or climbing crops with sticks to prevents lodging (falling over). Staking facilitates better growth and yield of crops. The benefits of staking include:

a. Improved light exposure: Staking allows plants to grow vertically, ensuring that they receive more sunlight, essential for photosynthesis.

b. Better aeration: Increased airflow around the plants reduces the risk of fungal diseases.

c. Optimised space usage: Vertical growth maximises available space, allowing more plants per unit area.

d. Reduced pest damage: Keeping plants, leaves and fruits off the ground minimises soil-borne pests and diseases.

e. Ease of harvesting: Upright plants are easier to harvest as the fruits are more visible and reachable.

f. Improved fruit quality: Fruits and vegetables that do not touch the ground are less likely to get dirty, bruised, or rot easily.

Mulching

This involves covering the soil around crops with various materials such as trash, straw, sawdust and compost. The benefits of mulching are:

a. Weed control: Mulch suppresses weed growth by blocking sunlight, which reduces the need for herbicides and manual weeding.

b. Moisture conservation: Mulching helps retain soil moisture by reducing evaporation during dry periods.

c. Temperature regulation: Mulch helps moderate soil temperatures, keeping it cooler to promote soil health and plant growth.

d. Soil health: Organic mulches decompose over time, adding organic matter to the soil, improving soil structure and promoting beneficial microbial activity.

e. Nutrient addition: Decomposing organic mulch releases nutrients into the soil, reducing the need for synthetic fertilisers.

f. Erosion control: Mulch protects the soil surface from erosion caused by wind and water.

Earthing up

Earthing-up is also known as hilling. It involves heaping soil around the base of plants, creating a raised bed or ridge along the rows of crops. This practice is common in the cultivation of tuber crops such as yams and sweet potatoes and other crops like maize, groundnut and Bambara groundnut. The importance of earthing up includes:

a. Plant stability,

b. Better root and tuber development,

c. Enhanced moisture retention.

d. Enhance pest and disease management.

Pest and disease management in arable crops

Arable crops – cereals, legumes, oilseeds, and roots and tubers – are susceptible to many pests and diseases. Effective management of these threats results in healthy crops, larger yields and quality produce. The table below shows some common pests and diseases affecting arable crops, and their management strategies.

Table 5.1: Common pests of arable crops and their control

Pest	Crops affected	Damage caused	Control measures
Aphids	Wheat, legumes, and yams	Sap-sucking insects that can cause stunted growth, reduced yields, and transmit viral diseases	Biological control using natural predators (e.g. ladybirds), application of recommended insecticides
Cutworms	Maize, soybeans, and various vegetables	Larvae eat young plants at the base, causing plant death.	Biological control with parasitic nematodes, and targeted insecticide applications.
Fall armyworms	Maize, rice, millet, cowpea.	They feed voraciously on the leaves, stems, and reproductive parts of plants.	Early planting, practise crop rotation, use recommended insecticide
Grasshoppers and locusts	Maize, cassava, cowpea	They eat the leaves and reduce photosynthetic ability of the leaves.	Use recommended insecticide, Early planting, biological control by using natural predators, practise crop rotation
Rodents such as grasscutters, rats, mice, ground squirrels.	Maize, millet, rice cassava, yam, legumes	They eat tubers and grains. Grasscutters cut and eat stems of crops as well.	Use of physical barriers, traps, and rodenticide baits

Birds – weaver and Quelea birds	Cereals- maize, rice, millet.	They eat the grain of cereals	Use of scarecrows and reflective tapes
Weevils	Maize, rice, millet,	They create holes in the grain and eat the kernel	Early harvesting to avoid field infestation, treating grains with recommended insecticides before storage.
Seed beetles	Cowpea, groundnuts Bambara groundnuts, peas	Feed inside the grain reducing its weight, viability and quality	Plant resistant varieties, early planting to avoid peak pest populations in the field, spray crops with the recommended insecticides.
Yam tuber beetle	Yam	Bore into the yam tuber and feed on the vine base.	Use the recommended insecticide, practise crop rotation
Termites	Cassava, yam, upland rice, maize	Destroy the roots of crops, eat crop stem especially during drought	Early harvesting of crops, use recommended insecticide.
Root knot nematodes	Yam, sweet potato, carrot, cowpea, groundnut.	Severely galled roots that affect water and nutrient absorption.	Crop rotation

Table 5.2: Major diseases of arable crops and their control

Disease and causative agent	Crops affected	Mode of transmission	Major symptoms	Control measures
Leaf mosaics - Caused by viruses	Cassava, yam, cowpea, maize	Piercing and sucking insects (e.g. aphids, whiteflies).	Irregular patterns of light and dark green, yellow, or white areas on the leaves Irregular leaf shapes and sizes, stunted growth.	Plant resistant varieties, practise crop rotation, rogue infected crops, attack the vector.

Powdery mildew Caused by fungi	Cereals, legumes	Airborne spores spread by air or water splash from rain or irrigation.	White, powdery fungal growth on leaves and stems, leading to reduced photosynthesis and yield	Plant resistant varieties, apply fungicides, proper spacing to improve air circulation.
Smut Caused by fungi	Maize, rice, sorghum and wheat	Spores are spread by wind, rain, and agricultural activities.	Large, greyish galls filled with dark, powdery spores on leaves, tassels, stalks, ears and grain.	Plant resistant varieties, practise crop rotation, treat seeds with appropriate fungicide, use certified, disease-free seeds
Rusts Caused by fungi	Maize, rice, sorghum, soybean, cowpea	Spores are spread by wind, rain splash, humans and farm machinery	Reddish-brown pustules (swellings) on leaves and stems, causing reduced photosynthesis and weak plants.	Remove and destroy infected crop residue, plant resistant varieties, Practise crop rotation, use recommended fungicides,
Blights Caused by fungi	Potatoes, legumes	Airborne spores, spread by water splash	Water-soaked lesions that turn brown and necrotic, leading to rapid plant decline.	Use resistant varieties, rotate crops, good farm sanitation practices, use appropriate fungicides
Leaf spot Caused by fungi	Yam, cassava. cowpea, groundnut	Airborne spores deposited on leaves	Appearance of dead spots on leaves reduces photosynthetic surface area	Use appropriate fungicide, practise crop rotation

Harvesting arable crops

Timing and harvesting methods are crucial in ensuring the best quality produce. Farmers should consider the following when arable crops are ready for harvesting:

a. Timing

i. **Maturity:** Crops must be harvested when they attain physiological maturity. In maize, a black layer at the base of the kernel signifies maturity. Harvesting too early or too late can affect yield and quality of produce.

ii. **Weather conditions:** Harvesting during dry weather is ideal to prevent spoilage and reduce drying costs.

b. Methods of harvesting

i. **Manual harvesting:** Suitable for small-scale operations or delicate crops that require careful handling. Tuber crops require simple farm tools like hoe, earth chisel and cutlass, while legumes are hand-picked. Cereals are harvested with sickles and cutlasses.

ii. **Mechanical harvesting:** Appropriate for large-scale farms, requires machinery like combine harvesters and pickers.

Activity 5.4: Post planting activities/cultural practices

In pairs, identify five post planting activities and discuss their importance to arable crop production. Present your findings to the larger class.

Project work

Find a friend, and experiment with different types of fertilisers to see their effect on plant growth and yield. Write a report and present your findings to the class.

Follow the steps below to conduct to achieve the project work.

Steps

1. Select plants: Choose a fast-growing crop such as maize or beans.
2. Prepare plots: Divide the planting area into equal-sized plots.
3. Apply fertilisers: Use different types (e.g., organic, inorganic) or varying amounts on each plot; leave one as a control with no fertiliser.
4. Plant seeds: Sow seeds uniformly across all plots.
5. Monitor growth: Record observations like plant height, leaf size, and colour weekly.
6. Measure yield: Harvest and weigh the produce from each plot.
7. Analyse results: Compare growth and yield to identify the most effective fertiliser type or application rate.
8. Prepare your report and present it to the larger class.

POST-HARVEST PRACTICES AND MARKETING OF SELECTED ARABLE CROP PRODUCE

Post-harvest practices in arable crop production

Post-harvest operations in arable crops involve processes aimed at ensuring high-quality produce is safe for consumption and ready for storage, processing, or marketing. These processes are detailed below:

1. Threshing: Threshing involves separating the grain from the straw, chaff, or pod. It can be done manually or mechanically.
    a. Manual threshing: In legumes, manual threshing is achieved by beating the pods packed in jute sacks with sticks or trampling the pods on clean floors after sun drying.
    b. Mechanical threshing: Using machines like threshers which are more efficient and less labour-intensive.
2. Cleaning: For cereals, it involves winnowing, sieving and air screening to remove debris, dust and unwanted materials from the grains. Winnowing is blowing air to remove lighter particles from the grains. Screening involves passing grains through sieves to remove unwanted materials. In tuber crops e.g. yams, potatoes and sweet potatoes, cleaning removes soil particles and dirt.
3. Drying: In cereals and legumes, drying is done to reduce the moisture content of the grains (usually below 14%) before storage. Legumes are spread thinly on mats or tarpaulins under the sun to dry. Fuel-powered driers can also be used for faster and more controlled drying. Cassava and other tubers are chopped into pieces before drying physically or mechanically.
4. Sorting and grading: Sorting and grading ensures quality, meeting consumer or industrial requirements. Sorting involves separating crops based on specific criteria to ensure uniformity and quality. The main criteria include size, colour, shape and quality. Grading categorises crops into different quality levels or grades based on established standards. Grading ensures that the crops meet specific market requirements and often determines their market price. Criteria for grading include size, weight, quality, moisture content and purity. The importance of sorting and grading include:
    a. **High market price:** Sorting and grading raises the value of the crops with consequent higher prices.
    b. **Consumer satisfaction:** Sorting and grading ensures that consumers receive high-quality products.
    c. **Compliance with standards:** Sorting and grading help meet local and international standards and regulations.
    d. **Waste reduction:** Sorting and grading reduces waste by identifying and putting lower-grade produce to alternative uses.

5. Handling: Handle tubers gently to avoid physical damage, which can lead to spoilage and reduced shelf life. Remove damaged or diseased tubers in the field to reduce the risk of spreading infections in storage.
6. Curing (for yams): Cure yams by storing them at 30-40°C (86-104°F) under shade with adequate ventilation for several days. This process helps heal wounds, reduces water loss and minimises rotting during storage.
7. Processing: Processing transforms raw agricultural produce into suitable forms for consumption, storage, or manufacturing. The methods and technologies used vary based on the type of crop and the desired end products.
    a. **Benefits of processing arable crops include:**
        - Addition of value to raw crops.
        - Extension of produce shelf life.
        - Increased profit margins for farmers and processors.
        - Wastage reduction.
        - Easier and longer storage and transportation.
        - Enhanced flavour and palatability.
        - Ensures compliance with regulatory and food safety standards.
    b. Examples of processed arable crops
        - Cassava: Can be processed into various products like flour, starch, chips, dough, and gari.
        - Yam: Processed into flour for “Neat” fufu and “Amala,” and chips.
        - Soya beans: Processed into oil, flour, soya milk and soya sauce.
        - Groundnut: Processed into oil, cake, paste, roasted nuts “Nkatie Borga.”
        - Cereals: Cereals are processed into flours. flakes, brans, pastas, and instant noodles.
8. Packaging: Packaging refers to the materials and containers used to protect, store, transport and display products. The benefits of proper packaging include:
    a. Protection of produce from crushing, bruising and breaking during handling, transportation and storage.
    b. Preservation of produce quality and freshness.
    c. Protection against dust, dirt, chemicals and other contaminants.
    d. Prevention of mould growth and spoilage.
    e. Protection from microbe, insect and rodent attack.
    f. Extension of shelf life without significant loss in quality.
    g. Easier handling and transportation.
    h. Better eye appeal to consumers.

i. Provides critical information about the product, including origin, nutritional content, and handling instructions.

9. Storage: Storage in arable crops refers to preserving harvested crops under controlled conditions to maintain their quality and prevent spoilage before they are sold or processed. Proper storage minimises losses due to pests, diseases, moisture and environmental factors.

   a. **Storage facilities:** Arable crops are stored in various facilities designed to maintain optimal conditions:

      i. **Silos:** Tall cylindrical structures used for storing large quantities of grains like maize, wheat, and barley. Silos protect grains from pests and moisture.

      ii. **Warehouses:** Large buildings used for storing bulk quantities of crops, providing protection from weather and pests.

      iii. **Bins and bunkers:** Smaller containers for temporary storage on farms or processing facilities.

      iv. **Pits and piles:** Open-air storage methods used for certain crops, but susceptible to weather and pest damage.

      v. **Barns and cribs:** Structures made from wood and thatch for cereals and yams

Figure 5.1: Local silo (Science Direct)

Figure 5.2: A crib (Science Direct)

Figure 5.3: Local silo (Science Direct)

Figure 5.4: Modern silo (Automation Ghana)

Marketing Arable Crops

Marketing arable crops involves strategies that focus on promotion and sales. These strategies can vary depending on the crop type, target market, and current market trends.

1. Distribution channels: Farmers can use the following market channels to market their produce successfully.
    a. **Direct sales:** Selling directly to consumers or retailers through farmers' markets, farm stands, or community-supported agriculture (CSA) programmes.
    b. **Wholesale markets:** Selling to wholesalers who resell to retailers or food processors.
    c. **Contracts:** Establishing contracts with buyers for future delivery at an agreed price.
2. Timing marketing of arable crops: This can help farmers to increase their profit margins. This can be achieved by:
    a. **Seasonal sales:** Timing sales to coincide with lean season or high-demand periods.
    b. **Storage and logistics:** Ensuring adequate storage facilities and efficient transportation to keep produce until "the price is right."
3. Promotion and advertising: Farmers can do the following to enhance the marketing of arable crop produce.
    a. **Branding:** Developing a unique identity for the farm or product.
    b. **Advertising:** Using print, digital, and social media to reach potential buyers.
    c. **Promotions:** Offering discounts, samples, or special deals to attract customers.

Activity 5.5: Post-harvesting operations and marketing strategies

In pairs, surf the Internet to identify ten post-harvest operations and discuss the importance of post-harvest operations in arable crop production. In addition, analyse strategies for marketing arable crops. Share your findings with the class.

Follow the steps below to achieve **Activity 5.5:**

1. Find a friend.
2. Surf the Internet to identify post-harvest operations and their importance, and discuss with your partner. Write down relevant notes.
3. Again, analyse strategies for marketing arable crops.

    Follow these steps to guide your strategies for marketing arable crops:

a. Identify crops: Select arable crops for analysis, such as maize, rice, or sorghum.
b. Research market demand: Investigate consumer preferences, prices, and trends.
c. Examine distribution channels: Analyse methods like local markets, wholesalers, or direct sales.
d. Evaluate pricing strategies: Compare competitive pricing, discounts, and seasonal variations.
e. Assess promotion methods: Look into advertising, packaging, and branding strategies.
f. Review case studies: Study successful marketing strategies used by farmers or organisations.
g. Propose improvements: Suggest better strategies for increasing sales and profitability.

4. Present your findings to the class.

REVIEW QUESTIONS

1. Effective marketing of any agricultural produce begins with market needs and assessment. Explain how the assessment of market needs for arable crops helps farmers' production and marketing.
2. Discuss four challenges farmers face in marketing arable crops.
3. Before seeds of arable crops can be planted or sown, a number of pre-planting activities need to be carried out. Explain any four of these pre-planting activities that should be performed before growing arable crops.
4. The certified maize seed that a farmer bought from SKG Agrochemical store recorded 90% seedling emergence. If the farmer puts 150 kg of maize seeds on his farm, how much seed, in Kg, will he/she lose?
5. Before arable crops are harvested, several post-planting activities must be carried out. Identify and explain any five of these post-planting activities for arable crops and explain the relevance of pruning and staking in arable crop production.
6. You have been given a container of pesticides, a knapsack sprayer, and water. Explain how you would mix the chemicals and apply the pesticides in arable crop production to control pests.
7. After arable crops are harvested, a number of post-harvesting activities are carried out, including grading, packaging, processing, freezing and storage. Explain each of these post-harvesting activities and examine at least five economic importance of each.

SECTION

6 PRODUCING ANIMALS FOR INCOME

Farming for jobs and incomes

Economic Production of Animals

INTRODUCTION

Welcome to section 6. This section equips you with practical skills and knowledge to plan, organise, produce, and market small ruminants, such as sheep and goats, for income generation and community development. In this section, you will be exploring essential topics like identifying resource and market needs, practical production techniques for small ruminants, and effective distribution and marketing strategies. Additionally, you will gain insights into rearing snails and grasscutters as alternative livestock ventures. Through hands-on activities and collaborative projects, you will connect animal production to fields like economics and business studies. This inclusive approach respects sociocultural and religious diversity, ensuring meaningful and relevant learning experiences for sustainable livelihoods.

Get ready to explore the principles of animal farming, ignite your curiosity, and build practical skills.

KEY IDEAS

- Assessing Market Needs for Ruminant Products: Refers to a systematic analysis of consumer demand, market trends, and supply chain dynamics to determine the potential profitability and scalability of small ruminant production in local and regional contexts.
- Entrepreneurship: This refers to an innovative application of business and management skills to animal production, aimed at creating profitable enterprises that address market demands while promoting sustainable agricultural practices.
- Integration of Economic and Business Concepts: This refers to the incorporation of economic principles such as cost management, profit analysis, and business planning into animal production practices, fostering entrepreneurial skills and financial sustainability.
- Markets: This refers to the economic environments or platforms, including local and regional buyers, wholesalers, and retailers, where the supply and demand for animal products such as meat, hides, or live animals are negotiated.
- Resources: Refers to the essential inputs, including physical, biological, financial, and human assets, required to successfully plan, initiate, and sustain small ruminant or alternative animal production ventures.
- Snail Rearing: This refers to specialised cultivation of snails as a sustainable agricultural practice, emphasising methods such as habitat preparation, feeding, and breeding to produce snails for commercial and nutritional purposes.

RESOURCES AND MARKET NEEDS FOR PRODUCING RUMINANTS

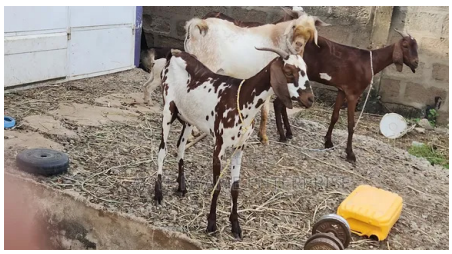
Ruminants are herbivorous grazing or browsing animals that can acquire nutrients from plant materials through microbial fermentation in a specialised stomach chamber before digestion. This process involves regurgitating the food and re-chewing it as "cud." They have a four-chambered stomach (rumen, reticulum, omasum and abomasum). The rumen is the largest compartment, where microbial fermentation occurs. The reticulum works with the rumen to mix and ferment the food. Water and nutrients from the digested food are absorbed in the omasum, while the abomasum or the "true stomach," is where enzymatic digestion occurs. Most ruminants have hooves with two digits, and they are the only animals that can digest their food without thorough chewing. Commonly known domesticated ruminants in Ghana are cattle, sheep and goats.

Resources for Small Ruminant Production

Ruminant production involves several essential resources that ensure the health and productivity of the animals while sustaining the system.

Key resources for establishing a small ruminant (Goat/ sheep) farm

1. Pasture land: Ruminants require adequate fenced grazing land or pasture.
2. Financial capital: Some capital is needed to establish the ruminant farm. Detailed financial planning and budgeting are required before making any investments.
3. Housing and infrastructure: Many farmers in Ghana wrongly believe sheep do not need shelter and can survive in the rain even at night. Proper housing should be provided to protect the animals from extreme weather and predators. This includes barns, sheds and windbreaks. There should be adequate space per animal to reduce stress and prevent diseases since overstocking can lead to increased aggression and health issues. Good ventilation is also necessary to reduce ammonia levels and reduce respiratory diseases. The infrastructure should include handling and feeding (e.g. water and feed troughs) and shade areas.
4. Breed selection and acquisition: Acquire suitable breeds for example Sahelian and West African dwarf goats. (See images A and B below), for the area and farming objectives, from reputable breeders or markets.



Sahelian goat breed

West African Dwarf breed

5. Feeding and nutrition: Quality feed including a mix of forages (e.g. pasture, hay and silage) and concentrates (e.g. grains, protein supplements) should be available since they are critical for the health and productivity of ruminants. Access to nutritional supplements is also required. The farmer should know the food requirements and feeding practices of ruminants. Feed availability varies with the seasons, necessitating storage solutions like preparing silage and hay to ensure a consistent supply. Mineral and vitamin supplements are essential to prevent deficiencies and support overall health and should be available. Goats and sheep require a constant and clean water supply. Adequate access points to water sources must be maintained to prevent competition and ensure all animals can drink as needed.
6. Health management: There is a need for veterinary care and access to a veterinarian for routine check-ups and emergencies, vaccination and disease prevention and control programmes, and regular deworming and parasite control strategies.
7. Crossing and breeding: Select animals with desirable genetic traits for crossing to produce healthy and vigorous offspring.
8. Regulatory and legal requirements: Farmers must comply with local regulations and permits related to farming operations, animal health and the environment.
9. Training and knowledge update: The farmer should continuously update his/her knowledge on the best practices in goat and sheep rearing through workshops, training courses, and industry information. Employees should be trained to manage feeding and monitor health and animal welfare.

Market Needs for Small Ruminant Production

The market needs encompass consumer demand, quality standards, pricing and supply chain logistics. Understanding these needs helps producers align their operations with market expectations, adhere to quality standards, manage pricing strategies, optimise supply and achieve economic sustainability.

Key market needs

1. **Market analysis**
    a. Consumer demand: Consumer preferences for sheep meat (mutton) and goat meat (chevon), ethically produced meat and ketogenic diets (high fat and low carbohydrate), influence market needs. Health considerations, cultural preferences, animal welfare and economic conditions play a role, just as the growing demand for organic and grass-fed animal products.
    b. Economic factors: Analyse the economic environment – income levels and purchasing power – on meat and dairy consumption.
2. Quality standards: Consumers nowadays are particular about product quality. It is, therefore, necessary to meet the quality standards for meat, such as tenderness, flavour, fat content and nutritional value. Compliance with safety regulations

and certifications ensures that products will be free from contaminants and disease-causing pathogens.

3. Pricing: Thorough knowledge of market dynamics helps to set competitive prices for meat and dairy products while ensuring profitability. Efficient management of production costs helps to maintain margins in the face of market price fluctuations.
4. Supply chain logistics: Effective distribution channels and timely delivery of products to markets are necessary. Cold chain logistics (including cold stores, refrigerators, cold vans, or trucks) maintain and preserve the quality and safety of perishable products.
5. Technological advancements: The role of technology in improving production efficiencies, such as advancements in animal health, feed and genetic improvements should be considered.
6. Regulatory environment: Compliance with local and international food safety standards is necessary. There is a need to assess the impact of environmental regulations on production methods, particularly concerning greenhouse gas emissions and sustainable practices.
7. Competitive analysis: Identify the key market players, including large-scale producers, small farmers and international competitors, and determine the market share of different players and the factors contributing to their success. It is also necessary to analyse how different producers differentiate their products through branding, quality and sustainability initiatives to meet standards.
8. Consumer behaviour: Study consumer purchasing patterns, including purchase frequency, preferred purchase channels (e.g. supermarkets, farmers' markets, online) and factors influencing purchase decisions. These enable producers to understand the price sensitivity of consumers and the impact of pricing strategies on demand.

Activity 6.1: Discovering small ruminant products

In pairs, investigate and identify the range of animal products found in homes and food joints. Write your findings on a piece of cardboard and paste it on the classroom wall for other classmates to read.

Steps to be followed for Activity 6.1:

1. Find a partner.
2. Discuss examples of animal products frequently used in homes and food joints. Some are edible while others may be used for clothing.
3. Classify animals as small ruminants (e.g. sheep and goats) or non-ruminants (e.g. chickens and pigs).
4. Write your findings on a piece of cardboard and paste it on the classroom wall for other classmates to read.

Project work

In pairs, visit a community market or cold store with a checklist and collect data on the most popular small ruminant products. Next, visit ruminant farms or watch videos showcasing the production and sale of small ruminants. Record your observations about the resources needed for production and the market demands for these products. Analyse your findings with your partner and prepare a detailed report, highlighting the key resources and market needs. Present your report to the class, ensuring respect for socio-cultural and religious differences.

Steps to be followed for the project work:

1. Choose a partner and develop a checklist on small ruminant products. You could include key information such as the type of products (e.g. meat, milk, wool, hides), their popularity, customer preferences, demand trends and pricing.
2. Visit the community market/cold store with your checklist to collect data on the small ruminant products which are most popular.
3. Again, visit a local ruminant farm or watch videos on the production and sale of small ruminant produce and products.
4. Record details about the resources required for production, such as feed, shelter, veterinary care, and labour, and document the sale process.
5. Discuss the collected data. You could include the following:
    a. The key resources needed for ruminant production.
    b. The market needs and demand patterns for small ruminant products.
    c. Any notable challenges observed during production or sales.
6. Summarise your findings in a well-organised group report and present to the class.

PRODUCTION OF SMALL RUMINANTS FOR MEAT

Small ruminants like sheep and goats contribute significantly to meat production worldwide. They are important in arid and semi-arid regions due to their adaptability to harsh environments and ability to convert low-quality forage into high-quality meat. Several factors, for example, breed selection, nutrition, health, reproduction and marketing, affect small ruminant production and profitability.

Management Practices

Small ruminants can be managed under various systems depending on the herd size and reason for rearing. The management can be under extensive, semi-intensive and intensive systems.

1. Extensive systems: This involves grazing on natural pastures with minimal supplementary feeding. It is common in sub-Saharan Africa and parts of Asia where the animals graze freely over large areas. The method can be cost-effective and environmentally sustainable.

Figure 6.1: Picture of goats grazing under an extensive system of farming

Advantages of the extensive system of keeping small ruminants	Disadvantages of the extensive system of keeping small ruminants
Suitable for small-scale farmers and those with limited resources.	Small ruminants are vulnerable to predators such as wolves, coyotes and dogs.
Efficient use of land unsuitable for crop production.	Requires significant effort for herding, predator control, and health monitoring over the large area.
Promotes ecological balance by utilising natural vegetation and maintaining soil fertility through manure.	Overgrazing can happen, leading to soil erosion, loss of vegetation, and land degradation.
The animals exhibit natural behaviours, leading to improved health and well-being.	Grazing areas might not always provide a balanced diet, leading to deficiencies or malnutrition, especially in seasons with poor forage quality.
Lower feed and housing costs as animals graze on natural pastures.	The animals are more exposed to harsh weather conditions that affect their health and productivity. Providing shelter in large areas is impractical.
Reduced labour cost.	Access to clean, reliable water sources is a challenge, especially in arid or semi-arid regions.

Lower disease incidence due to reduced animal density and natural grazing behaviours.	It is difficult to monitor and control diseases in extensive systems. Infections can spread quickly among animals and timely veterinary interventions may be less feasible.
Reduced medication and treatment costs.	

2. Semi-intensive systems: These combine grazing with supplemental feeding, often practised in Mediterranean and Latin American countries. Semi-intensive systems restrict the small ruminants to relatively small areas with controlled feed, water and care. This method can be highly productive.

Advantages of the semi-intensive system of keeping small ruminants	Disadvantages of the semi-intensive system of keeping small ruminants
Animals benefit from natural grazing and supplemental feeding, ensuring a more balanced and nutritious diet. This can lead to better health, growth rates, and productivity.	While generally lower cost than fully intensive systems, semi-intensive systems still require significant investment in infrastructure, such as fencing, shelters, and feeding facilities, which can be a financial burden for some farmers.
The animals are better monitored than in extensive systems, allowing for early detection and treatment of diseases.	Balancing the needs of grazing with supplemental feeding and health care requires careful planning and management, which can be complex and time-consuming.
Animals exhibit natural behaviours by grazing in open spaces, which improves their overall welfare and reduces stress compared to intensive confinement.	If not managed properly, semi-intensive systems can lead to localised overgrazing, soil compaction, and nutrient runoff, negatively impacting the environment.
They reduce overgrazing and soil erosion, promoting better land management and environmental sustainability.	Semi-intensive systems are still partially dependent on weather conditions for pasture growth. Droughts or heavy rains can affect the availability and quality of pasture, necessitating additional feed and increasing costs.
They can be more cost-effective than fully intensive systems, as they require less investment in infrastructure and rely partially on natural forage, reducing feed costs.	Maintaining fences, water systems and shelters requires ongoing investment and labour that can be costly.
They are generally less labour-intensive than fully intensive systems, as animals can graze and move freely within designated areas.	While less a problem than in extensive systems, predation still exists, especially when animals are grazing. Ensuring their safety can require additional resources and management.

Properly managed semi-intensive systems can help minimise the environmental impact of farming by balancing grazing pressure and reducing the need for chemical inputs.	Ensuring a reliable supply of clean water for both grazing and confined areas can be challenging and may require significant investment in water infrastructure.

3. Intensive systems: High-input systems where animals are confined and provided with formulated feeds, commonly found in industrialised nations.

Figure 6.2: Picture of goats in an intensive system of farming

Advantages of the intensive system of keeping small ruminants	Disadvantages of the intensive system of keeping small ruminants
The animals receive a carefully balanced diet tailored to their needs, leading to better growth rates, milk production and overall health.	Intensive systems require a significant upfront investment in infrastructure, equipment and technology, which can be a barrier for small-scale or resource-limited farmers.
Maintains a healthier flock, as it is easier to detect diseases early and administer vaccinations or treatments promptly.	Feed, veterinary care, labour, and maintenance costs are higher in intensive systems compared to extensive systems.
Intensive systems often use modern technology and practices to optimise feed, water and other resources, resulting in higher productivity per input unit.	The close confinement of animals increases the risk of disease transmission. Outbreaks can spread rapidly, leading to significant losses.
Higher meat, milk, and wool production due to better nutrition, health management and breeding practices.	Intensive systems can generate large amounts of waste, which, if not managed properly, can lead to environmental pollution, including water contamination and soil degradation.
Although intensive systems require more daily labour, the tasks are often more predictable and manageable. Automation and mechanisation can further enhance labour efficiency.	Intensive systems typically consume more energy for heating, cooling, lighting and operating equipment, contributing to higher greenhouse gas emissions.

The system allows for better control of the animals' environment, protecting them from harsh weather and reducing predation.	The high density of animals can lead to stress, aggression and a higher incidence of injuries and diseases, raising animal welfare concerns.
With animals in a confined area, it is easier to collect and manage waste, which can be used as fertiliser or for biogas production, contributing to environmental sustainability.	Intensive systems rely on external inputs such as commercial feed, veterinary products and energy, which can be subject to price fluctuations and supply chain disruptions.
Intensive systems can produce animals with more consistent size, weight and health.	Managing an intensive system requires skilled labour for tasks like feeding, health monitoring and breeding management, which can be costly and difficult to source.
Intensive systems provide opportunities for training, research and advanced husbandry techniques, contributing to the advancement of small ruminant farming practices.	Inbreeding reduces resilience, making the population more susceptible to diseases and environmental stresses.
The animals receive a carefully balanced diet tailored to their needs, leading to better growth rates, milk production and overall health.	Intensive systems often rely on advanced technology and mechanisation, which require regular maintenance and can be expensive to repair or replace.

Table 6.1: Comparison of extensive, semi-intensive, and intensive systems for keeping small ruminants

S/N	Aspect	Rearing system		
		Extensive	Semi-intensive	Intensive
1	Input costs	Low	Moderate	High
2	Animal welfare	High, natural behaviours encouraged	Moderate, some confinement	Variable, limited natural behaviours
3	Labour requirements	Low	Moderate	High
4	Predation risk	High	Moderate	Low
5	Disease and parasite exposure	High	Moderate	Low
6	Land use	Utilises marginal lands	Requires moderate-quality land	Requires high-quality land

7	Feed dependency	Low, relies on natural forage	Moderate, supplemented with feed	High, relies on commercial feeds
8	Environmental impact	Low, promotes biodiversity, less concentrated waste	Moderate, balanced approach	High potential for pollution and concentrated waste
9	Weather dependency	High, animals exposed to elements	Moderate, some shelter provided	Low, animals housed in controlled environments
10	Productivity (growth & milk)	Low	Moderate	High
11	Management challenges	High, difficult to monitor and manage large areas	Moderate, balance between extensive and intensive challenges	Low, easy monitoring and control

4. Factors influencing production

a. **Selection of breeding stock:** Selecting the parents or the initial stock for starting ruminant rearing should be based on desirable traits to ensure the viability and sustainability of the enterprise. The selection criteria should be based on the appearance of the animal. For example, the rib cage should not be visible, and the pelvis area should be plump.

b. **Care of pregnant animals:** This involves adequate nutrition, regular health check-ups and management during the gestation period.

   i. **Nutrition:** Pregnant small ruminants require a balanced diet, rich in energy, protein, vitamins, and minerals. Nutritional needs increase significantly during the last trimester of pregnancy when foetal growth is most rapid. Inadequate nutrition can lead to poor foetal development, low birth weights, and increased mortality rates.

   ii. **Health management:** Regular veterinary check-ups prevent diseases. Vaccinations and parasite control should be part of the routine care. Pregnant animals are more susceptible to diseases, which can impact the developing foetus.

   iii. **Housing:** Providing a clean, dry and comfortable environment reduces stress and the risk of infections of pregnant small ruminants.

c. Care for the young animals: Adequate care for young small ruminants, such as kids (goats) and lambs (sheep), is crucial for their survival, growth and overall health.

   i. Nutrition

- Colostrum: This is the first form of breastmilk released by the mammary glands after giving birth. Newborn animals need to consume colostrum within the first few hours of life to receive essential antibodies and nutrients.
- Milk feeding: This is the process of feeding a mother's breast milk to her baby. After colostrum, young ruminants require the mother's milk or a balanced milk replacer. The feeding schedule and amount should be tailored to the age and growth requirements.
- Weaning: Weaning is the gradual transition of young animals from a milk-based diet to a solid-feed diet. Introducing high-quality forage and concentrates helps in the proper development of the digestive system.

ii. Health management

. Young animals are more susceptible to diseases and infections than adults, hence requiring proper health management. Young ruminants should receive vaccinations according to a prescribed schedule to protect them from common diseases. Regular deworming and monitoring for external parasites are essential to prevent infestations that can affect their growth and health.

iii. Housing and environment: Extreme weather and poor housing can adversely affect the health and growth of young ruminants. The young animals should be provided with clean, dry and well-ventilated housing to minimise the risk of diseases. Appropriate bedding materials should be used to keep the environment comfortable and reduce the risk of infections.

d. Managing pests and diseases

Effective management of pests and diseases in small ruminants ensures health, productivity, and overall well-being. Internal and external parasites and infectious diseases can negatively affect growth rates, reproductive performance and overall herd health. Some external parasites include lice, mites, ticks, and flies. They are controlled with the use of topical or systemic insecticides, proper management of housing and grazing areas and regular monitoring of animals for signs of infestations. The common internal parasites (Endoparasites) include nematodes and tapeworms in the intestines, coccidia and liver flukes. They can be controlled by implementing regular deworming schedules. Common infectious diseases include pneumonia, foot rot and bluetongue. They can be prevented through vaccination programmes, good hygiene practices and regular veterinary check-ups. Biosecurity measures: Biosecurity protocols should be implemented to prevent the introduction and spread of diseases. This includes quarantine procedures for new or sick animals and controlling traffic within the farm.

Examples of ectoparasites of small ruminants

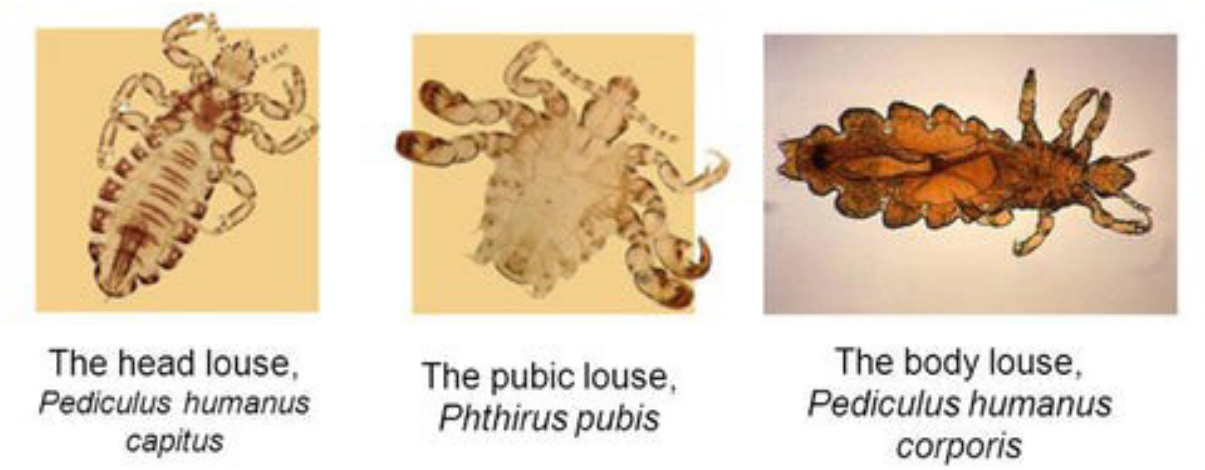


Figure 6. 3: Different species of lice on small ruminants

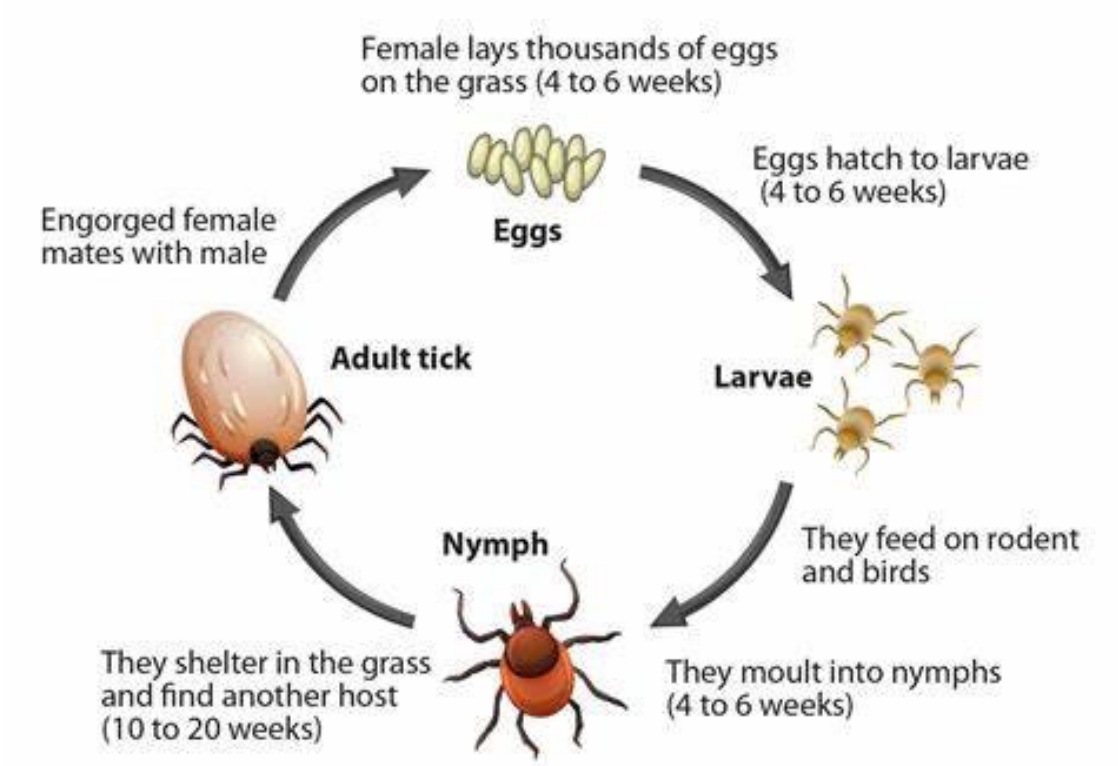


Figure 6.4: Developmental stages of a tick species

Figure 6.5: Blow fly adult Figure 6.6: larvae (maggots)

Examples of endoparasites of small ruminants

Figure 6.7: Tapeworm

Figure 6.8: Roundworms

Activity 6.2: Evaluating Small Ruminant Management Systems

In pairs, identify and discuss the different management systems used for small ruminant production in Ghana. In addition, explain the benefits of using the management systems to produce small ruminants for meat effectively. Present your findings to the class.

Activity 6:3: Impact of Breeding and Health Practices

In pairs, visit an established small ruminant farm to gather information on critical aspects of breeding stock selection and health management, pen construction, feed and water rations, and sources of vaccines. Again, collect data on breeding stock selection criteria, care for pregnant and young animals, and methods for managing pests and diseases. Record your observations in your field notebook and present your findings to the class.

Steps to be followed for Activity 6.3:

1. With your partner, visit an established small ruminant farm.
2. Prepare your field notebook with sections for observing and recording data.
3. Gather details about the visit and document all observations in the field notebook.

You could include the following in your engagement with the farm manager:

4. The setup for pen construction, noting materials used and design considerations.
5. Feed and water rations, including frequency and types of feed provided.
6. Vaccination schedules, vaccine sources, and any protocols followed to prevent diseases.

7. How breeding stock is selected, focusing on traits like health, productivity, and genetic quality.
8. Care routines for pregnant and young animals, including feeding, sheltering, and health checks.
9. Review and discuss the collected data with your partner.
10. Prepare a summary of your findings, using charts or tables and present to the class.

MARKETING OF RUMINANT PRODUCE AND PRODUCTS

Marketing the produce and products of ruminants involves several strategies and considerations to reach and persuade consumers. It starts with slaughtering the animals either by the farmers or at designated slaughterhouses (Abattoirs) and processing it for meat and other products. Producers and marketers can effectively promote and sell ruminant products, build strong relationships with consumers, and ensure business growth by focusing on these strategies.

Examples of ruminant products:

1. Dairy: Milk, cheese/"wagashi," yoghurt, butter and cream.
2. Meat: Chevon (goat) and mutton (sheep).
3. By-products: Hide, leather, wool, manure, bones for feed and fertiliser and tallow (obtained by rendering or melting down the fat tissue) for cooking, making soap, candles, lubricants and biodiesel.

Steps in Marketing Produce and Products

1. **State of the abattoir**

   The meat's hygienic state depends on the abattoir's cleanliness, and how the animal is prepared after slaughtering and handled until they reach the sales point. An unhygienic abattoir is a major concern for many consumers.

2. **Understanding the market**

   a. Market research: Market research should be conducted to identify target consumers and understand their preferences, trends, competition and purchasing behaviours. Potential market segments such as organic, non-GMO, local, grass-fed, or free-range products should also be identified.

   b. Target consumers: Define the target consumers based on their buying behaviour.

3. **Product advertising**
    a. Branding: A strong brand acceptable to consumers, with a clear message, logo, and tagline, should be developed. Unique selling messages like sustainability, health benefits, or ethical farming practices should be highlighted.
    b. Packaging: Attractive, appealing, functional and informative packaging, that communicates the quality and benefits of the products, should be used. Clear information about the product, including the origin has to be provided. There is a need to consider eco-friendly packaging to appeal to environmentally conscious consumers.
    c. Value-added products: Products like cheese, yoghurt and leather goods should be provided.
4. **Marketing channels**
    a. Direct-to-consumer: Products could be sold directly to identified groups such as workplaces and other consumers through farmers' markets and online stores. Products can also be delivered via subscription services.
    b. Retail and wholesale local retailers: Farmers can partner with local grocery stores, specialty food stores and co-operatives to reach more consumers.
    c. Food services and wholesale: Products can also be supplied to restaurants, hotels, larger retailers and institutions.
    d. Digital marketing:
        i. **Website:** A user-friendly website with detailed product information, recipes, and farm stories can be created, ensuring that it is optimised for search engines.
        ii. **Social media:** Any social media platform can be used to engage consumers, share behind-the-scenes content, and promote/showcase products.
        iii. **Email marketing:** Farmers should build an email list of consumers and send regular newsletters with updates, promotions, recipes and educational content.
5. **Content marketing**
    a. Educational content: Blog posts, videos, and infographics that educate consumers about the benefits of ruminant products, sustainable farming practices and recipes should be created.
    b. Storytelling: It is necessary to share the story of the farm, the animals, and the people behind the products to build a personal connection with consumers while emphasising sustainable practices and animal welfare.
6. **Promotion and advertising**
    a. Local advertising: Farmers can use local newspapers, radio, community bulletin boards and information centres to reach nearby consumers.

b. Online advertising: They should also utilise Google ads, social media ads, and influencer partnerships to increase visibility and drive traffic to the website. The superior quality of products should be highlighted.

c. Promotions: It is essential to offer discounts, bundle deals, and loyalty programmes to increase sales. Events should be hosted occasionally at the farm in partnership with local businesses to taste the product. Food bloggers and influencers should be engaged to reach a broader audience and also engage with media outlets to feature stories about the farm and its products.

7. **Quality assurance**

a. Certifications: Obtain relevant certifications such as organic, non-GMO, or animal welfare certifications to build trust with consumers.

b. Transparency: Farmers should be transparent about farming practices and production methods.

8. **Distribution and logistics**

a. Efficient supply chain: Develop a reliable supply chain to ensure products reach consumers fresh and in good condition.

b. Cold chain management: Establish a proper refrigeration system during transportation and storage.

9. **Customer service**

a. Responsive communication: Provide excellent customer service by promptly responding to inquiries and concerns.

b. Feedback mechanism: Encourage and act on customer feedback to improve products and services.

10. **Ethics and sustainability practices:**

a. Eco-friendly practices: Implement sustainable farming and production practices to appeal to environmentally conscious consumers.

b. Animal welfare: Ensure high standards of animal welfare and communicate these practices to consumers.

Activity 6.4: Marketing of Small Ruminant Products

Find a friend and identify the various products obtained from small ruminants. Again, discuss the distribution outlets in your community and ways of marketing the ruminant products. Record your findings in your notebook and share them with your peers in class.

Follow the steps below to perform **Activity 6.4:**

1. Surf the Internet with your partner and identify the various products obtained from small ruminants, such as meat, milk, hides, wool, and manure.

2. Discuss the common distribution outlets for small ruminant products in your community. You could focus on the following in your discussion:
   a. Local markets and retailers.
   b. Wholesale distributors and export opportunities.
   c. Online platforms and direct-to-consumer sales.
3. Discuss ways of marketing the ruminants produced in your community. You could consider factors such as:
   a. Pricing and promotion techniques.
   b. Branding and packaging.
   c. Target markets and customer preferences.
4. Share your findings with your peers.

SNAIL REARING

Snail farming, also known as **heliciculture**, involves rearing land snails for human consumption, cosmetic use, and other purposes. This agricultural activity involves breeding, rearing and harvesting snails in controlled environments to ensure optimal growth and productivity. Here are some key aspects of snail farming:

Key Components of Snail Farming

1. Species selection

The most commonly farmed snail species in Africa is Achatina achatina (Giant African snail), also referred to as 'Nwapa' in Ghana. Archachatina marginata (Giant African land snail) and Achatina fulica are other less cultured snails in Ghana. The most reliable way of obtaining breeding stock is from known breeders or agricultural institutes. These parent snails can be more expensive than snails from other sources, but they are better and safer because they have been properly fed and managed from hatching and have not been injured during collection and subsequent handling.

Figure 6.9: Picture of Achatina achatina. Source: Wikipedia

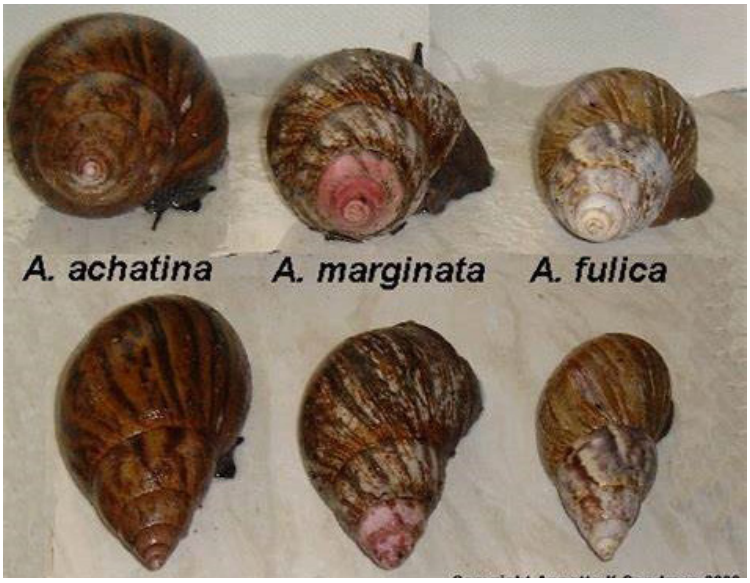


Figure 6.10: Picture showing the various types of snails (Source: Annette K Goodman, 2000)

2. Farm setup

a. Site selection: Choose a location with suitable soil, climate and access to water. Soils with high organic matter support the growth and development of snails. Generally, if the soil supports the growth of cocoyam, tomatoes and leafy vegetables, it is suitable for snail farming.

b. Choosing the rearing system: There are several methods and systems for rearing snails. The rearing environment, or snailery, should be controlled, such as in greenhouses, plastic tunnels, or indoor facilities. The various snaileries are:

   i. **Box or cage system:** Snails are raised in boxes or cages made from wood, plastic, used car tyres, or metal mesh.

   ii. **Pen system:** Snails are kept in outdoor pens made of wood, metal, concrete, or plastic, with a mesh or netting cover to prevent escape.

   iii. **Trench system:** Trenches are dug into the ground and lined with bricks or wood to create a controlled environment. Trenches must have proper drainage to prevent waterlogging and maintain optimal humidity levels.

   iv. **Indoor system:** Snails are raised indoors where temperature, humidity and lighting can be regulated. The greenhouse farming concept is used under this system. Allows for year-round production and protection from predators and adverse weather. They feed on natural vegetation and organic matter found within the area.

Figure 6.11: Picture of a Box pen for snail rearing

Figure 6.12: Picture of a large-scale concrete pen

3. Key considerations for all methods

a. Snails flourish on a balanced diet of vegetables, fruits and calcium sources for healthy growth, including the shell, and reproduction.

b. Maintaining appropriate moisture and humidity levels is crucial, as snails thrive in moist conditions.

c. Snails require moderately low temperatures (15-25°C) to thrive; extreme heat or cold can be detrimental.

d. Snails need soil for burrowing and laying eggs. The soil should be loose, well-drained, and rich in calcium and organic matter.

e. Pest and disease monitoring and management to ensure a healthy snail population.

f. Protect the snails from direct sunlight and predators.

4. Breeding and reproduction

a. Mating: Snails are hermaphrodites (each has both male and female reproductive organs) and can fertilise each other. Mating can last several hours and typically occurs during the rainy season.

b. Egg laying: Snails will lay eggs in the soil a few days after mating. One snail can lay hundreds of eggs per clutch.

c. Incubation: Maintain proper moisture and temperature to ensure the eggs hatch successfully. This usually takes about 2-4 weeks.

d. After hatching, provide a secure and moist environment for the young snails. Feed them with finely chopped greens and calcium-rich foods. Gradually increase their diet variety as they grow.

5. **Feeding:** Feeding snails properly is crucial for their growth, health and reproduction. Here are some guidelines on feeding snails:

a. Nutritional requirements

i. **Calcium:** Essential for shell development. Sources include crushed eggshells and limestone powder.

ii. **Protein:** Needed for growth and reproduction. Protein-rich foods include legumes, fish meal and leafy vegetables.

iii. **Carbohydrates:** Tubers, fruits, and vegetables provide energy.

iv. **Vitamins and minerals:** Maintain overall health. A balanced diet with a variety of foods usually covers these needs.

b. Types of feed

i. **Green vegetables:** Fresh cocoyam leaves, lettuce, cabbage, spinach and other leafy greens are excellent choices.

ii. **Fruits:** Bananas, melons and pawpaw. Avoid citrus fruits as they can be too acidic.

iii. **Tubers:** Cassava, yams and sweet potatoes.

iv. **Supplementary feeds:** Commercial snail feed, specially formulated to ensure a balanced diet.

c. Feeding practices

i. **Quantity:** Snails should be fed based on size and population density. Overfeeding can lead to waste, while underfeeding can stunt growth and affect reproduction.

ii. **Frequency:** Feed snails once or twice a day. Evening feeding is recommended since snails are more active at night.

iii. **Hygiene:** Remove any uneaten food daily to prevent mould and pests. Clean feeding areas regularly.

d. Provision of water: Provide clean, fresh water daily. Snails need moisture to thrive and for the digestive process. Use shallow dishes to prevent drowning, or soak pieces of foam in water and place them in the pen.

6. Health and hygiene management

a. Pests

i. **Rats and mice:** These rodents are major predators of snails. They can cause substantial damage by eating the snails and their eggs.

ii. **Birds:** Some birds, like the crow, prey on snails, particularly during the early morning.

iii. **Frogs and toads:** Amphibians like frogs and toads can consume juvenile snails.

iv. **Ants:** Certain ant species, for example, driver ants, invade snail pens, feeding on eggs, juveniles and even adult snails.

v. **Mites:** Mites can parasitise snails, causing irritation and possible infections.

vi. **Nematodes:** Parasitic nematodes can infest snails, leading to diseases and reduced productivity.

b. Diseases

Bacterial Infections	Fungal Infections	Protozoan Infections	Pest control measures
Pseudomonas spp.: Can cause shell disease and lesions on the snail's body.	Fusarium spp: Causes soft shell and foot rot, leading to the weakening of the snail's shell and body.	Ciliates and Amoebae: These single-celled organisms can cause digestive and other health problems in snails.	Quarantine: Isolating new snails before introducing them to the main population can help prevent the spread of diseases.
Aeromonas hydrophila: Known to cause infections leading to tissue damage and eventual death.	Penicillium spp.: Another fungus that can cause shell deterioration.		Sanitation: Regular cleaning of snail housing and removal of waste can prevent the build-up of harmful pathogens.
			Mechanical control: Using physical barriers to prevent entry of rodents and birds.

			Insecticidal control: Controlling insect populations around the farm using recommended insecticides.

7. Harvesting and cleaning

a. Maturity: Harvesting snails when they reach marketable size, typically between 6 to 12 months old. Look for snails with thickened and fully formed lips at the shell opening. Avoid harvesting smaller snails with thinner shells and underdeveloped lips, as these are still growing.

b. Handling: Gently pick up the snails by the shell to avoid injuring them. Hold them firmly but gently to prevent them from slipping out of your grasp. Place the collected snails in a well-ventilated container to prevent suffocation. Avoid overcrowding the container to ensure adequate aeration.

c. Cleaning: Clean and purge the snails to remove contaminants before consumption or sale.

8. Marketing and sales

a. Market identification: Identify and target markets for snail meat, mucus and other by-products.

b. Packaging and distribution: Ensuring snails are packaged hygienically and distributed efficiently to reach consumers.

c. Sales: Snails are sold in various market outlets, including roadside markets in Ghana.

Activity 6.5: Process and activities in snail rearing

In pairs, search on the Internet for information on the processes and activities involved in snail rearing and discuss your findings with your other classmates.

Project work

With the same partner, look for locally available materials in your locality and undertake a snail-rearing project in your school.

Hint: Follow the steps below to assist you in undertaking the project work.

1. Create a snail housing using old car tyres, metal drums, large plastic containers, wood, or concrete tanks.

2. Prepare substrate or bedding material (Coconut coir, peat moss, or sawdust, rice chaff, mixed with black soil).
3. Acquire snail stock from a certified source.
4. Provide suitable feed daily.
5. Moisten the environment with clean, fresh water regularly.
6. Monitor and manage pests and diseases.
7. Write a comprehensive report to your teacher and share your experience with other peers.

BENEFITS OF SNAIL REARING

Rearing snails or heliciculture offers several financial, health and social benefits. Some of the benefits are:

Financial benefits

1. Low start-up costs: Snail farming requires relatively simple infrastructure, such as snail pens or containers and basic tools for feeding and maintenance. Snails primarily consume vegetables, fruits and organic waste, which can be sourced locally for free or at low costs. This frees up money for other ventures.
2. High market demand: Snails are considered a delicacy in many parts of the world, creating a high demand for snail meat (escargot) which offers farmers high prices for their produce.
3. Quick reproduction cycle: Snails reproduce quickly and in large numbers, allowing farmers to scale their operations and increase production quickly.
4. High profit margins: Due to their delicacy status and various applications, snails can be sold at premium prices in local and international markets.
5. Diverse revenue streams: Farmers can sell snail meat, mucus, and eggs (a delicacy known as “white caviar”). In addition, snail shells for decorative or industrial purposes offer farmers multiple sources of income.
6. Low risk and maintenance: Snails are generally hardy and resistant to many diseases that affect other livestock. Snail farming does not require intensive labour, making it easier to manage compared to other farming types thus increasing farmers’ returns on investment.
7. Governmental and institutional support: In some regions, governments and agricultural institutions provide subsidies, grants and training programmes to encourage snail farming. These financial supports help farmers to establish profitable and sustainable snail farming businesses for income generation.

Health benefits

1. Good protein source: Snail meat is an excellent source of protein and essential amino acids, for muscle repair, growth and overall body function.
2. Low in fat: Snail meat has low-fat content, making it a healthier alternative to many traditional protein sources.
3. Vitamins: Snail meat is a good source of vitamin B12. This vitamin is important for nerve function, DNA production and red blood cell formation.
4. Minerals: Snail meat is rich in iron, needed for red blood cell production and the prevention of anaemia. It is also a good source of magnesium, which helps with muscle and nerve function, blood sugar control and blood pressure regulation.
5. Low caloric content: The low-calorie content of snail meat makes it an ideal food for those managing their weight.
6. Health benefits of snail mucus: Snail mucus contains allantoin, glycolic acid and collagen, which are beneficial for skin regeneration, hydration and healing. It also helps to reduce wrinkles and improve overall skin texture, making it a popular ingredient in anti-ageing skincare products.
7. Omega-3 fatty acids: Snail meat contains Omega-3 fatty acids, which promote heart health by lowering blood pressure and preventing heart disease.
8. Immune system booster: Snail meat is rich in zinc and other trace elements required for a healthy immune system, helping the body fight infections and illnesses effectively.
9. Digestive health: The chitin in snail meat acts as dietary fibre, promoting healthy digestion and preventing constipation.

Social benefits

1. Job creation and employment: Snail farming can create jobs in rural and urban areas, providing employment for locals and reducing unemployment rates.
2. Improved livelihoods: Snail farming can improve the living standards of families and communities, by providing a source of income, leading to better access to education, healthcare and other essential services.
3. Economic growth: The increased economic activity from snail farming can stimulate local economies, encouraging further development and investment in the area.
4. Social inclusion: Snail farming is accessible to women, youth and the elderly, promoting inclusivity and diversity in agriculture.
5. Social empowerment: Marginalised groups get opportunities to generate income and improve their social standing.
6. Cultural significance: In many cultures, snail consumption is a traditional practice and promoting snail farming can help preserve and celebrate cultural heritage.

7. Promoting a healthy environment: Snail farming is environmentally friendly, as they are reared on organic waste, contributing to a cleaner environment.

Activity 6.6: Benefits of Snail Rearing

In pairs, surf the Internet to identify the financial, health and social benefits of snail rearing and discuss your findings among yourselves. Again, discuss and compare the benefits of snail farming to traditional animal production. Share your findings with other peers.

GRASSCUTTER REARING

The grasscutter (Thryonomys swinderianus) is also called a cane rat. Grasscutters are large rodents found in Africa. They resemble but are bigger and stouter than rats, which have longer tails. Their meat is a delicacy in many parts of the continent and is sold at premium prices. Grasscutter rearing is an increasing enterprise in West Africa, where they are reared for meat. Their rearing involves several processes and practices to be successful and ensure the animals are healthy and productive. Here are some of the main procedures and activities in grasscutter rearing

Figure 6.13: Picture of a grasscutter

Figure 6.14: Picture of a rat

Housing Infrastructure

Different housing designs and structures can be used in various settings, such as farms and backyard breeding arenas. The choice of housing depends on factors like climate, available space and materials and the specific needs of the grasscutter.

Some common types of grasscutter housing

1. Wire mesh cages: These are simple and affordable.
2. Metal cages: These are wire mesh structures secured with metal frames.

Click on the link to watch metal cages for grasscutter: https://youtu.be/cFUHfD043J4

3. Wooden cages: These are wire mesh structures secured with wood frames.
4. Concrete pens: They are made of a concrete base but covered with wire mesh. These cages are durable and easy to clean.
5. Breeding pens: Specialised cages for breeding and raising young grasscutters.

Management and Construction of Grasscutter Houses

1. Cage size: Grasscutters need sufficient space to move, eat and rest comfortably. Overcrowding can lead to stress and disease. For breeding, a space of about 2 m^2 per adult animal is recommended.
2. Construction material: Use durable materials like concrete, metal or wood to prevent escape and ensure longevity. The floor should be made of concrete to facilitate cleaning and prevent burrowing and escape.
3. Ventilation: Proper ventilation is essential to prevent respiratory diseases. Proper air circulation can be achieved by including windows or ventilation openings but protect these openings with wire mesh to prevent escape.
4. Lighting: Provide natural light during the day while ensuring some shaded areas to protect animals from direct sunlight. Artificial lighting can be used to extend daylight hours, especially in breeding pens.
5. Temperature and humidity: Grasscutters thrive in a warm environment, ideally between 25°C and 30°C. Maintain moderate humidity levels by creating enough windows in concrete pens; high humidity can cause respiratory issues, while low humidity can lead to dehydration.
6. Shelter: Provide hiding places or shelters within the pens to mimic their natural habitats. Use wooden boxes, PVC pipes or specially designed shelters for the shelters.

Grasscutter Breeding

1. Selection of breeding stock: The breeding stock can be procured from certified breeding farms or selected from other farmers using the following criteria:
    a. Age: Select animals that are at least 6-8 months old to ensure they are mature enough for breeding.
    b. Health: Choose animals that are healthy, free from disease and have no physical deformities.
    c. Temperament: Choose animals with a calm and docile temperament, as they are easier to handle.

d. Growth rate: Choose animals with a fast growth rate to ensure quick maturity.

e. Maternal care: Select females whose mothers show good mothering ability to ensure they can care for their offspring.

f. Litter size: Choose females that are daughters of high-littering mothers.

2. Recommended breeding ratio and mating: Typically, one male is kept with multiple females (1:4 ratio) to maximise breeding efficiency. Allow the male and female to mate naturally but monitor to be sure mating has taken place.

3. Gestation and birth: The gestation period for grasscutters is about 5-6 months. Provide a comfortable and secluded area for pregnant females to give birth. After birth, the female needs special care and attention. She must be given high-quality feed and adequate clean water to aid milk production.

4. Weaning: Weaning is the separation of the mother from her young ones, which should be done 40 days after birth. This is necessary to free the mother for rebreeding. Gradually, introduce young grasscutters to solid foods alongside their mother's milk to ensure a smooth transition.

Feeding Guidelines

1. Nutrient requirements: Grasscutters require a fibre-rich diet (forage) with moderate protein content. For optimal growth and reproduction, a diet with about 12-16% crude protein augmented with minerals and vitamins is recommended as supplemental to the primary forage. Other additives include common salt and commercial mineral mixes.

2. Feed composition:

   a. Forage: Grasscutters primarily feed on grasses such as elephant grass (Pennisetum purpureum), guinea grass (Panicum maximum) and other local forage. These grasses should be fresh and free from contaminants.

   b. Supplementary feeds: While grasses form the bulk of their diet, supplementary feeds like maize, cassava tubers and peels, sugarcane and coconut fronds can be supplied.

   c. Concentrates: Commercial rodent feed or specially formulated concentrates can be used to ensure a balanced diet, particularly for breeding and growing animals.

3. Feeding practices:

   a. Quantity: Give grasscutters balanced and adequate feed to promote healthy growth and development. They should be fed twice a day (morning and evening).

   b. Water: Provide clean water at all times. Water containers should be cleaned regularly to prevent contamination.

4. Feeding pregnant and lactating females: Increase protein intake and provide additional minerals and vitamins to support the increased nutritional requirements.

Pests of Grasscutters

External parasites

a. **Mites:** These can cause itching, hair loss and skin irritation. Regular inspection and the use of recommended acaricides can help control mite infestations.

Figure 6.15: Picture of a mite

b. Ticks: Ticks can transmit diseases and cause anaemia. They can be controlled by maintaining cleanliness and using tick repellents or acaricides.

Figure 6.16: Picture of a tick

c. Fleas and lice: These pests can cause discomfort and transmit diseases. Regular cleaning and the use of insecticidal treatments are essential.

Figure 6.17: Picture of a flea Figure 6.17: Picture of a louse

Internal parasitic worms

Grasscutters can be infested by intestinal worms, such as roundworms and tapeworms, leading to weight loss, diarrhoea and poor growth. Deworming with appropriate anthelmintics is recommended.

Diseases of Grasscutters

1. Bacterial diseases:
    a. Salmonellosis: Caused by Salmonella bacteria, this disease can lead to diarrhoea, dehydration and death. Maintaining good hygiene and proper food handling can prevent outbreaks.
    b. Pasteurellosis: Caused by Pasteurella bacteria. This disease can cause respiratory disease. Antibiotic treatment and good ventilation can control the disease.
2. Viral diseases:
    a. Rabies: Grasscutters can contract rabies through bites from infected animals. Vaccination and restriction of wild grasscutter populations can prevent this disease.
    b. Arenavirus infection: This virus can cause haemorrhagic fever in grasscutters. Preventive measures include restricting wild rodent populations and maintaining good hygiene.
3. Fungal diseases:
    a. Ringworm: This fungal infection causes circular, itchy lesions on the skin. Treatment involves antifungal medications and maintaining proper sanitation.
    b. Aspergillosis: Caused by Aspergillus fungi, whose spores cause respiratory disease. Ensuring good ventilation and using antifungal treatments can help manage infections.
4. Nutritional diseases:
    a. Vitamin and mineral deficiencies: Inadequate nutrition can lead to poor growth, weak bones and reproductive problems. Providing a balanced diet with necessary supplements is crucial.
    b. Scurvy: Caused by a deficiency in vitamin C. This disease can lead to swollen joints, bleeding gums and lethargy. Including vitamin C-rich foods in the diet can prevent scurvy.

Record Keeping

1. Breeding records: Keep detailed records of breeding activities, including mating dates, birth dates and litter sizes.
2. Health records: Maintain records of vaccinations, treatments and any health issues observed.
3. Feeding records: Document feeding schedules and any changes in diet.

Table 6.2: Breeding Record Template

Date	Male ID	Female ID	Mating Date	Expected Birth Date	Actual Birth Date	Litter Size	Remarks
10-01-2025	M001	F001	10-01-2025	10-06-2025	12-06-2025	5	Successful, healthy litter

Table 6.3: Health Record Template

Date	Grasscutter ID	Health Check	Symptoms Observed	Vaccinations/ Treatments	Medication Given	Follow-Up Date	Remarks
15-01-2025	G001	Good	Slight limp in right leg	Rabies Vaccine	Anti-inflammatory	22-01-2025	Monitor limp

Table 6.4: Feeding Record Template

Date	Grasscutter ID	Type of Feed	Quantity	Supplementary Feed	Water Provided	Remarks
10-01-2025	G001	Fresh Grass	1 kg	Corn	500 ml	Eating well
10-01-2025	G002	Cassava Peels	0.8 kg	Commercial Pellets		

Handling Grasscutters

Handle grasscutters gently to minimise stress and injury. Use proper techniques when moving or inspecting the animals.

1. Handling techniques

a. Approach: Approach the grasscutter slowly and calmly to avoid startling it. Speak softly to reassure the animal if necessary.

b. Securing the animal:

i. **Small grasscutters:** Grab them gently but firmly around the shoulders using one hand, while supporting their hindquarters with the other hand.

ii. **Large grasscutters:** Use both hands to grab the animal around the shoulders and support its body weight with the other hand, ensuring that the grip is firm to prevent it from wriggling free.

2. **Safety tips**
    a. Bites and scratches: Grasscutters can bite or scratch if threatened. Always handle them with care and respect. Wear gloves to prevent bites or scratches. Do not handle grasscutters by their tails, as this can cause injury.
    b. Health precautions: Wash the hands thoroughly before and after handling grasscutters to prevent the spread of diseases. Regularly clean and disinfect handling equipment to maintain hygiene.
3. Training and familiarity: Regularly handle young grasscutters to get them accustomed to human interaction. This can make handling easier as they grow older. Observe their behaviour to understand individual temperament and adjust your handling technique accordingly.
4. Social interaction: Grasscutters are social animals. Keeping them in groups can promote natural behaviours and reduce stress.

Marketing and Sales

1. Market research: Identify potential markets for grasscutter meat and products. Understand consumer preferences and demand.
2. Sales channels: Explore various sales channels, including local markets, restaurants and direct sales to consumers.

Activity 6.7: Processes and activities in grasscutter farming

In pairs, surf the Internet, list and discuss the processes and activities involved in grasscutter farming. Share your findings with other peers.

Activity 6.8: Video documentary on grasscutter farming

With the same partner, watch the video documentaries on grasscutter farming below, discuss your observations and present your findings to the class. (Use this link: https://www.bing.com/videos/riverview/g&mid=E10FDD00CDF3BEEB0597E10FDD00CDF3BEEB0597&FORM=VIRE)

BENEFITS OF GRASSCUTTER REARING

Grasscutter rearing offers several financial, social and health benefits, making it an attractive venture for both small-scale and commercial farmers. These benefits include:

Financial Benefits

1. High market price: Grasscutter meat is a delicacy in many parts of Africa and commands a high market price.
2. Small initial starter finances: Grasscutters can be reared in relatively small spaces compared to larger livestock, reducing land, housing and infrastructure costs. It is suitable for urban and peri-urban farming where space is limited.
3. Low feeding costs: Grasscutters primarily feed on grasses and agricultural by-products, which are usually low-cost or freely available. This reduces the overall feed costs compared to other livestock that require expensive commercial feeds.
4. Quick return on investment: Grasscutters reach marketable size relatively quickly, often within 5-7 months. This allows for quicker turnover and faster realisation of profits.
5. Job creation: Grasscutter farming can create full-time and part time employment for workers, unemployed and retired people.
6. Income diversification: Grasscutter rearing offers an additional source of income, helping to diversify and stabilise household earnings. It provides a financial buffer against crop failures and other agricultural risks.
7. Low costs of veterinary services: Grasscutters are hardy animals with relatively small expenditure in treating pests and diseases. They have fewer health issues and diseases compared to other livestock, which reduces veterinary costs.
8. High reproductive rate: Grasscutters have a high reproductive rate, with females giving birth to multiple litters per year. Each litter can contain 4-8 offspring, leading to rapid population growth and increased production. They reach sexual maturity in a maximum of seven months and are ready to reproduce.

Social Benefits

1. Empowerment of marginalised groups: Grasscutter rearing can be an income-generating activity for women, youth and other marginalised groups. It promotes economic inclusion and gender equality by empowering these groups to participate in agricultural enterprises.
2. Reduction in rural-urban migration: Engaging the rural youth in grasscutter farming can reduce rural-urban migration.
3. Rural poverty reduction: Grasscutter rearing supports rural development by providing livelihoods and reducing poverty.

4. Enhanced nutrition: Grasscutter meat is a rich source of high-quality protein, essential vitamins and minerals, contributing to improved nutrition. It provides a healthy and affordable alternative to other meat sources, especially in regions where protein deficiency is common.
5. Diet diversification: Including grasscutter meat in the diet helps diversify food sources and reduces reliance on traditional livestock. This diversification can enhance the nutritional status of communities and reduce malnutrition.
6. Rural development: Grasscutter farming can stimulate rural economies by creating new business opportunities and increasing household incomes, contributing to rural development.
7. Sustainable land use: Grasscutter farming requires less land compared to traditional livestock farming, promoting efficient use of available land resources. It can be integrated into existing crop or animal production.

Health Benefits

1. High-quality protein source: Grasscutter meat is rich in high-quality protein, which is essential for overall body function. Consuming grasscutter meat can help prevent protein deficiency, especially in regions where other protein sources are scarce, expensive, or taboo.
2. Low-fat content: Grasscutter meat is lean, with lower fat content than other types of meat like pork and beef, hence recommended for a healthy heart and weight management.
3. Reduced zoonotic disease risk: Controlled farming environments lower the risk of disease transmission between animals and humans.
4. Enhanced food safety: Rearing grasscutters in a controlled environment allows for better regulation of food safety standards. This reduces the risk of foodborne illnesses caused by consuming contaminated meat.
5. Wild game conservation: Domesticated grasscutter farming reduces the need for wild hunting, hence preserving wild game.

Activity 6.9: Benefits of Grasscutter farming

In pairs, surf the Internet and other sources for the financial, social and health benefits of grasscutter rearing, and compare it with ruminant production. In addition, search for how grasscutter rearing can enhance food security in Ghana and discuss your findings with other class members.

EXTENDED READING

- Anim-Jnr et al., 2023. Sustainable small ruminant production in low- and middle-income African countries: Harnessing the potential of agroecology. Sustainability, 15(21), 15326. https://doi.org/10.3390/su152115326

- Mahamed, S. A., & Ali, H. Y. (2023). Small ruminant production and marketing practices in Harawa, Somali Region, Ethiopia. Open Journal of Animal Sciences, 13(2), 240–260. https://doi.org/10.4236/ojas.2023.132018
- Agricultural and Food Economics. (2023). Economic benefits of livestock management in Ghana. Agricultural and Food Economics Journal. Retrieved from https://agrifoodecon.springeropen.com/articles/10.1186/s40100-023-00263-2
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- https://www.wikihow.com/Build-a-Snail-House

REVIEW QUESTIONS

1. Explain two ways the knowledge of resource and market needs enhances the production of small ruminants.
2. Outline how consumer behaviour can affect the sale of goat meat (chevon).
3. Discuss two advantages and two disadvantages of the three management systems used for keeping small ruminants.
4. Explain the benefits of breed selection and health management to the production of small ruminants for meat.
5. Mastering the art of marketing is key to success in the livestock industry. Explain any four steps in marketing ruminant produce and products.
6. Building trust and connection drives sales—ethics and engagement are the game changers! How will ethics and customer engagement improve the sale of ruminant products?
7. Breeding snails is the foundation of a thriving farm. Explain breeding in snail farming.
8. Protecting snails from pests is vital for success. Evaluate the effectiveness of measures to protect snails from pests.
9. Snail meat is packed with nutrition and health benefits. Explain four health benefits of snail meat.
10. Grasscutter farming involves a range of activities. Explain three activities in grasscutter farming.
11. Grasscutter farming is more than a livelihood. Explain three social benefits of grasscutter farming.
12. Grasscutter farming offers unique advantages. Examine three reasons grasscutter farming is more beneficial than ruminant production.

SECTION

7

SUPPORT SYSTEMS IN AGRICULTURE

Mobilisation of Resources and Networks

Support systems in Agriculture

INTRODUCTION

Welcome to section 7! In Ghana, several organisations and institutions support agriculture. These organisations are important because they help farmers, traders and processors. This support makes farming more productive, profitable, and long-lasting, which helps with food security and economic growth. Because of this, this section seeks to introduce you to support organisations in the agricultural sector and the help they offer to farmers. This section aims to help you learn enough about the support organisations and the help you can get from them as a future stakeholder in the agricultural sector. By the end of the section, you will be able to:

- Identify relevant support organisations offering services to farmers, traders, and processors.
- Describe the interactions among key stakeholders in the commodity value chain.
- Describe the Agricultural Knowledge and Innovation Systems (AKIS) approach and methods.

KEY IDEAS

- **Agricultural development:** This refers to the process of enhancing agricultural productivity, improving rural livelihoods, and promoting sustainable farming practices.
- **Agricultural knowledge and innovation systems:** This refers to a system that links people and organisations to promote mutual learning and to generate, share, and utilise agriculture-related technology, knowledge, and information.
- **Agricultural value chain:** This refers to the sequence of activities from agricultural production to consumption.
- **Non-governmental organisation (NGO):** This refers to independent, non-profit entities operating separately from government.
- **Organisation:** This refers to a structured entity with defined goals, roles, and responsibilities.
- **Stakeholder:** This refers to individuals or groups with a vested interest in an organisation or project.

SUPPORT ORGANISATIONS FOR ARABLE CROP FARMERS, TRADERS AND PROCESSORS

Governmental and Local Non-Governmental Organisations (NGOs) Supporting Arable Crop Farmers, Traders and Processors.

Governmental and local organisations in Ghana help farmers, traders, and processors of arable crops through a variety of programmes, initiatives, and services. The aim is to enhance productivity/output, improve people's lives, and make it easier for them to get to markets. These are some of the organisations and the support they offer.

1. **Council for Scientific and Industrial Research (CSIR)**
    a. Research and development: Through its seven agriculture-related institutes, it works on developing improved crop varieties, varieties that are resistant to pests, and sustainable farming practices.
    b. Technical assistance: Providing scientific and technical support to farmers and processors to enhance the output and quality of the product.
2. Ministry of Food and Agriculture (MoFA)
    a. Extension services: MoFA offers agricultural extension services to teach farmers about new ways to farm, pest management and best practices.
    b. Input subsidy programmes: Programmes like the Planting for Food and Jobs (PFJ) give subsidised seeds, fertilisers and other inputs to farmers to help boost crop production.
    c. Training and capacity building: Regular training programmes for farmers on improved agricultural practices, post-harvest management and value addition.
    d. Market access facilitation: Helping farmers find markets for their farm produce by setting up trade fairs and connecting them with buyers.
3. Ghana Irrigation Development Authority (GIDA)
    a. Irrigation infrastructure: building and taking care of irrigation systems to make sure that crops always have water, especially in dry areas.
    b. Technical support: Training farmers on how to use water and irrigation techniques more efficiently.
4. Peasant Farmers Association of Ghana (PFAG)
    a. Advocacy: Speaking up for small-scale farmers and urging the government to back them and make polices that help them.
    b. Capacity building: Giving them training and resources to help them get better at working, being productive, and running a business.

5. Farmer-Based Organisations (FBOs)
    a. Cooperative activities: These allow farmers to share resources, get inputs, and sell their goods as a group.
    b. Training and support: Teach farmers about modern agricultural techniques, financial management and market strategies.
6. Ghana National Association of Farmers and Fishermen (GNAFF)
    a. Representation and advocacy: Speaking up for the needs and interests of farmers at the national and local levels.
    b. Support services give farmers and processors access to training, inputs, and markets.
7. Women in Agricultural Development (WIAD)
    a. Gender-focused programmes: Empowering women in agriculture through training, providing resources, and advocating for policies that take gender into account.
    b. Support services: Give women farmers and processors special help, like getting access to credit or loans, inputs, and markets.
8. Ghana Agricultural Sector Investment Programme (GASIP)
    a. Integrated support: GASIP, implemented by MoFA with help from IFAD, helps smallholder farmers in many ways, such as by infrastructure development, giving them access to markets, and capacity building.
    b. Value chain development: Improving value chains for different crops to make them more efficient, reduce post-harvest losses and increase incomes.
9. Northern Rural Growth Programme (NRGP)
    a. Rural development focus: Rural development aims to help people in northern Ghana make better living conditions by developing agriculture, improving infrastructure, and making markets easier to access.
    b. Support for processors: Giving processors training, access to equipment and links to markets to help them add more value.
10. Ghana Investment Promotion Centre (GIPC)
    a. Investment promotion: Attracting investments in the agricultural sector, including funding opportunities and incentives for agribusinesses.
    b. Support services: Giving advice and making it easier for local farmers/processors and foreign investors to work together.
11. National Board for Small-Scale Industries (NBSSI)
    a. Business development services: Giving small-scale farmers and processors training, financial literacy programmes, and capacity building.
    b. Access to finance: Making it easier for farming businesses to get loans and other financial services that are tailored to their needs.

12. Ghana Standards Authority (GSA)
    a. Certification of agricultural products: The GSA makes sure that agrarian products meet national and international standards by certifying them. It helps farmers sell their products in other foreign markets.
    b. Standards compliance support: This helps traders understand and follow the standards required for exporting products to international markets.
    c. Product quality assessment and verification: Makes sure that products traded domestically and internationally meet the required quality and safety standards.

Roles of International Organisations Involved in Agriculture Development in Ghana

International organisations play an important role in agricultural development in Ghana through various initiatives, funding, technical assistance and policy support. Some key contributions of international organisations to Ghana's agricultural sector include:

1. Funding and investment
    a. World Bank: The World Bank gives a lot of money to farming projects in Ghana. One example is the Ghana Commercial Agriculture Project (GCAP), which helps smallholder farmers get better at farming and selling their crops.
    b. International Fund for Agricultural Development (IFAD): IFAD helps rural development projects in Ghana that focus on making the small-scale farmers' lives better. Their programmes often aim to reduce poverty and make sure people have enough food.
    c. Agricultural Development Bank (AfDB): AfDB gives financial products and services, including loans, savings and insurance for farmers and agribusinesses.
2. Technical assistance and capacity building
    a. Food and Agriculture Organisation (FAO): FAO offers technical advice and capacity-building programmes to improve agricultural practices, pest control, and sustainable farming methods. In addition, they help make and carry out policies.
    b. International Fertiliser Development Centre (IFDC): The IFDC promotes soil fertility and agricultural productivity through sustainable fertiliser use and soil health practices.
3. Research and innovation
    a. Consultative Group on International Agricultural Research (CGIAR): CGIAR centres such as the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria, the International Livestock Research Institute in Ethiopia and Kenya, research crop and animal improvement, pest management, and policy analysis to support Ghana's agricultural development.

   b. USAID (United States Agency for International Development): USAID funds research and development projects that aim to make farming more productive and less vulnerable to climate change through its Feed the Future programme.

   c. Agricultural Development Bank (AfDB): Gives financial support for post-graduate training in agriculture.

4. Infrastructure development

   a. AfDB: AfDB finances infrastructure projects that support agricultural development, including irrigation systems, rural roads and market facilities. The aim of the project is to reduce post-harvest losses and help farmers get to markets more easily.

   b. European Union (EU): The EU helps develop agricultural infrastructure through a number of projects and programmes that aim to improve the whole agricultural value chain.

5. Policy and advocacy

   a. United Nations Development Programme (UNDP): The UNDP supports policy development and implementation to create an enabling environment for agricultural growth. They work on policies related to climate change adaptation, sustainable agriculture and rural development.

   b. World Food Programme (WFP): The WFP provides food assistance and promotes food security policies. They support school feeding programs and initiatives to reduce malnutrition among vulnerable populations.

6. Market access and trade facilitation

   a. International Trade Centre (ITC): The ITC trains Ghanaian farmers and agribusinesses on how to use international markets by teaching them about quality standards, packaging and marketing. They also facilitate trade missions and partnerships.

   b. World Trade Organisation (WTO): The WTO and the government of Ghana work together to improve trade policies and regulations. This makes it easier for agricultural products to reach foreign markets.

7. Climate change and sustainability support

   a. Global Environment Facility (GEF): GEF funds projects that address climate change impacts on agriculture, promoting sustainable practices and resilience-building measures.

   b. Green Climate Fund (GCF): The GCF helps farmers access financial resources to support climate adaptation and mitigation projects in the agricultural sector, helping farmers cope with changing climate conditions.

8. Emergency relief and resilience building

   a. International Red Cross Society and Red Crescent Movement: They help farmers in times of disaster like pest outbreaks, droughts and floods. They also work to make communities more resistant to future shocks.

b. World Vision and other NGOs: World Vision International and other nongovernmental organisations work together to provide emergency assistance, support agricultural recovery and enhance long-term resilience.

Activity 7.1: Organisations Involved in Agriculture

In pairs, surf the Internet to list the support organisations involved in agriculture and classify them as governmental, non-governmental and international organisations. Again, discuss the roles of the organisations and present a report to your teacher.

STAKEHOLDER LINKAGE AND INTERACTIONS

In Ghana, many stakeholders are involved in the agricultural commodity value chains. These stakeholders are producers, processors, distributors, marketers and consumers. For the agricultural system to work well, everyone in the value chain of agricultural commodities must be able to get along with each other and interact well. These interactions enhance communication, improve resource allocation, foster innovation, and make sure that the needs and interests of all stakeholders are addressed.

Specific Roles of Key Stakeholders in the Agricultural Value Chain

1. **Farmers/producers.** They make the raw materials the primary commodities in the value chain. Smallholders and commercial farmers, and plantation operators are involved. For their enterprises to succeed, they work with financial agencies, input suppliers, extension services providers, cooperatives and traders.
2. **Input suppliers:** Provide essential inputs such as seeds, fertilisers, pesticides, and farming equipment. Companies that sell seeds, fertiliser, agrochemicals, machinery and equipment are all stakeholders. Their input ensures the success and sustainability of producers.
3. **Extension services:** They help farmers with technical support, training and education on modern farming techniques. Government agencies (like the Ministry of Food and Agriculture), Non-Governmental Organisations (NGOs) and private sector consultants are involved. To boost production, they work with farmers, research institutions and development agencies.
4. **Research and development institutions:** They innovate and develop new agricultural technologies, practices and improved crop varieties. Some of the institutions are the Council for Scientific and Industrial Research (CSIR), Universities and International Research Organisations. They work together

with extension services and farmers to disseminate and commercialise new technologies.

5. **Cooperatives and farmer organisations:** These groups help farmers by negotiating with buyers and making it easier for them to get money and inputs. The Ghana National Association of Farmers and Fishermen (GNAFF) and the Farmer-Based Organisation (FBO) Peasant Farmers Association of Ghana are examples.
6. **Traders:** They buy goods or produce from producers and group them so they can sell them to processors and consumers. They are made up of middlemen, wholesalers and retailers. Traders work with farmers, cooperatives, processors and exporters to facilitate the flow of produce.
7. **Processors:** They transform the produce into finished or semi-finished products. Small-scale processors, medium to large-scale agro-industries and food processing companies are key actors. They work with packaging companies, get raw materials from producers and traders, and engage with wholesalers and retailers.
8. **Consumers:** They buy and eat agricultural produce and products. This involves individual households, restaurants, hotels and institutions. They influence market demand and provide feedback through buying behaviours, taste and preferences.
9. **Financial institutions:** Commercial banks, microfinance institutions and rural banks all offer loans/credit and other financial services to different stakeholders. They work with development agencies to offer loans and financial products to farmers, cooperatives and agribusinesses.
10. **Government and policymakers:** They regulate and support the agricultural sector through policies and programmes. They implement policies affecting all stakeholders, provide subsidies and incentives and collaborate with international organisations for development projects.
11. **NGOs and development agencies:** They take part in agricultural development by working on projects, advocacy and capacity building. Examples Include USAID, World Bank, IFAD and Alliance for Green Revolution in Africa (AGRA). They work with farmers, cooperatives and communities to implement development projects and partner with governments and research institutions to develop agricultural innovations.
12. **Exporters:** They make it easier for agricultural products to be sent to foreign markets. To meet export standards and get access to foreign markets, they work together with traders, processors and government agencies.

Strategies to Enhance Stakeholder Linkages

1. Strengthening cooperatives: Empowering farmer cooperatives can enhance collective bargaining power, improve access to markets and manage their resources better.

2. Improving access to information: Using ICT tools to give real-time information on things like weather reports, best agricultural practices and market prices, can help stakeholders make better decisions.
3. Facilitating financial inclusion: Making financial products that are specific to different stakeholders can make it easier for people in the value chain to access loans/ credit and invest.
4. Promoting public-private partnerships: Encouraging collaboration between the government, private sector, and NGOs can leverage resources and expertise for sustainable value chain development.
5. Enhancing infrastructure: Investing in transportation, storage and processing infrastructure can reduce post-harvest losses and make the value chain work better.
6. Policy and regulatory support: Putting in place policies and regulations that are good for businesses can create an enabling environment for value chain development.

Relevance of The Interactions Between Various Stakeholders in The Agricultural Commodity Value Chain

Different stakeholders in the agricultural commodity value chain need to interact with each other for the agricultural sector to be efficient, sustainable and successful overall. These interactions make it easier for information, resources and services to flow, which helps each stakeholder do their job better. Here are some interactions and their relevance:

1. **Research and extension institutions and farmers**
    a. Problem-solving: Research institutions, farmers and extension workers all work together to find solutions to problems that farmers face, like pest infestations, soil degradation and climate change impacts.
    b. Innovation and technology transfer: Research institutions develop new technologies and practices that significantly improve agricultural productivity and sustainability. Effective interactions ensure these innovations reach farmers.
2. **Farmers and input suppliers**
    a. Access to quality inputs: Farmers rely on input suppliers for seeds, fertilisers, pesticides, and machinery. Farmers need high-quality inputs to grow crops, and effective interactions make sure they get them.
    b. Technical support: Suppliers of inputs often give technical advice on how to use inputs correctly, which can make farms more productive and sustainable.
3. **Farmers and extension services**
    a. Knowledge transfer: Extension services offer training and information on best farming practices, pest control and new technologies, to help farmers improve yields and reduce losses.

b. Adoption of innovations: Regular interactions encourage the adoption of innovative farming techniques and practices, which can make the business more productive and profitable.

4. Farmers and financial institutions

a. Access to credit: Banks and other financial institutions give farmers the necessary capital for purchasing inputs, investing in technology and expanding operations. Effective interactions ensure that farmers have access to affordable credit.

b. Risk management: Insurance products offered by financial institutions help farmers manage risks associated with crop failure, extreme weather and market volatility.

5. Farmers and cooperatives

a. Collective bargaining: Cooperatives help farmers get better deals on inputs and produce, which lowers costs and raises income.

b. Resource sharing: Cooperatives make it easy for people to share resources such as machinery, storage facilities and transportation, which saves cost and time.

6. Farmers and processors

a. Market access: Processors provide markets for farmers' produce, ensuring a steady demand and reducing post-harvest losses.

b. Quality standards: Processors often set quality standards that farmers must meet. This encourages farmers to use better farming practices and quality control measures.

7. Processors and distributors

a. **Supply chain efficiency:** Efficient interactions between processors and distributors ensure a smooth flow of goods from processing plants to retailers and consumers.

b. **Market feedback:** Distributors provide market feedback to producers and processors, helping them adjust production to meet consumer preferences and demands.

8. Government and all stakeholders

a. Policy and regulation: Government policies and regulations impact every stakeholder in the value chain. Effective communication ensures that policies are aligned with the needs of the agricultural sector.

b. Support programmes: Government programmes, such as subsidies, grants, and training initiatives, support stakeholders in improving productivity and profitability to ensure sustainability.

9. Non-Governmental Organisations (NGOs) and stakeholders

a. Capacity building: NGOs offer training and capacity-building programs, helping farmers and other stakeholders improve their skills and knowledge.

b. Advocacy: NGOs fight for the rights and interests of smallholder farmers and other vulnerable groups, making sure that their voices are heard when policies are being made.

10. Consumers and producers

a. Demand and preferences: Patterns of demand and consumer preferences affect choices about production. Direct interactions, such as through farmers' markets or consumer feedback mechanisms, help producers align their produce with market needs.

b. Food safety and quality: As consumers become more concerned about food safety and quality, producers are forced to improve their practices and standards.

Activity 7.2: Stakeholder linkages and interactions

1. Find a friend, identify and explain the roles of the key stakeholders involved in the agricultural value chain.
2. Discuss the relevance of the interactions among the stakeholders involved in the agricultural value chain.
3. Present their findings to the class

IMPORTANCE OF AGRICULTURAL KNOWLEDGE AND INNOVATION SYSTEMS IN EXTENSION DELIVERY

Agricultural Knowledge and Information Systems (AKIS) in extension education is a framework that integrates various sources of knowledge generation, information dissemination and application to support and improve agricultural practices and outcomes. AKIS involves people, institutions, technologies and processes in innovation development, extension and application. It helps policymakers, researchers, extension workers, and farmers by making it easier for information to flow and encouraging innovation and resources needed to improve their productivity, sustainability, and livelihoods.

Key Components of AKIS

1. Knowledge creation: Research is done by Institutions, universities and agricultural organisations to come up with new technologies, practices, and solutions to agricultural challenges. Farmers can share their local knowledge

and experiences, which can lead to the co-creation of solutions that are practical and effective.

2. Knowledge dissemination: Extension agents and services act as intermediaries in translating research findings into practical advice and disseminating information to farmers. To educate farmers about new technologies and techniques, workshops, field days, and training sessions are organised. Digital platforms like websites, mobile apps, and social media provide access to agricultural information and connect farmers with experts and peers.
3. Knowledge utilisation: Farmers, Agricultural Cooperatives, Processors, Agribusinesses, Youth in Agriculture, traders and marketers use the knowledge and practices shared through AKIS to improve their production, distribution and processing.

Roles of AKIS in Extension Delivery

1. Information sharing: This makes sure that farmers receive timely, up-to-date and useful information on weather forecasts, crop management, pest control and market trends. Information is tailored to local contexts and conditions, making it more applicable and effective for specific regions and farming systems.
2. Capacity building: AKIS helps farmers and extensionists keep learning by offering training programmes, workshops, Farmer Field Schools and Fora and educational materials for an upgrade of skills and knowledge.
3. Innovation and technology transfer: AKIS helps researchers and farmers work together, which facilitates the transfer of innovations.
4. Support for decision-making: AKIS helps farmers make informed decisions regarding crop selection, pest management, irrigation and other critical aspects of farming by providing reliable and timely information. This makes sure that risks are better managed.
5. Policy and programme support: AKIS data are used by policymakers to formulate agricultural policies and programmes. Stakeholders engage to promote a coordinated approach to agricultural development.

Importance of AKIS in Extension Delivery

1. Support for innovation: AKIS encourages the development and dissemination of new technologies and practices, which help farmers use innovative approaches that make their work more productive and efficient.
2. Enhanced research-extension linkage: The communication channels between researchers, extension agents and farmers are strengthened for easier information flow.
3. Enhanced extension services: AKIS supports the efficient delivery of extension services by providing extension agents with the tools and information they need to support farmers effectively. For continuous improvement, it sets up ways for farmers to give feedback on extension services.

4. Increased adoption of best practices: It helps farmers use the best agricultural practices, which leads to increased productivity and sustainability.
5. Resource optimisation: It helps farmers get the most out of resources like water, fertilisers and labour, reducing waste and increasing sustainability.
6. Promotes sustainable agriculture: AKIS promotes the use of sustainable farming practices that protect natural resources, reduce negative environmental impact, and make sure that agricultural systems will be around for a long time.
7. Community networking and development: AKIS helps farmers, extension agents, researchers, agribusinesses, policymakers and other stakeholders work together and build networks. This encourages community development and problem-solving as a group.
8. Increased productivity: AKIS can give farmers access to innovative practices that can lead to larger crop yields, improved livestock production and better overall farm management.
9. Risk management: AKIS helps farmers manage risks and reduce their vulnerability to adverse events by giving them information on weather patterns, pest outbreaks and market fluctuations.
10. Capacity building: AKIS helps educate and train farmers, extension workers and other stakeholders, which improves their skills and knowledge and gives them the power to implement innovative solutions.
11. Policy development: The data and insights generated by AKIS help policymakers design and carry out policies that promote agricultural development, food security, and sustainable rural livelihoods.

Activity 7.3: Agricultural Knowledge and Information Systems (Case Study)

In the Nsoatre community, tomato farming is a primary source of livelihood for most households. However, farmers face challenges such as low yields, limited access to markets, and poor adoption of improved farming practices.

In pairs, imagine you are local agricultural extension officers, work together to identify and discuss the roles of the key components of AKIS needed to address these challenges. Present your findings to the larger class.

Follow the steps below to achieve Activity 7.3:

1. Read and understand the case study
    a. Review the case study on tomato production in the Nsoatre community.
    b. Highlight key points, such as stakeholders involved, challenges faced by the farmers, and methods used to address those challenges.
2. Identify key components of AKIS

   c. Take the components (For example, farmers, extension agents, research institutions, market actors, and government/NGOs).
   c. Discuss the role of each component in solving the challenges faced by the tomato farmers.

3. Map out the AKIS network
   a. Create a diagram showing how the components of AKIS interact.
   b. Use arrows to show the flow of information and collaboration between stakeholders (e.g. Research institutions providing seeds to farmers).
4. Present your findings to the larger class

REVIEW QUESTIONS

1. Organisations play a crucial role in supporting the agricultural sector. Discuss four ways organisations assist farmers, traders, and processors in improving their productivity, access to markets, and overall efficiency.
2. Support organisations play vital roles in strengthening the agricultural sector. Develop a checklist of the key functions these organisations perform to assist farmers, traders, and processors.
3. The agricultural value chain involves multiple stakeholders working together to ensure the success of agricultural production and distribution. Explain the roles of three key stakeholders in the agricultural value chain.
4. In the agricultural value chain, stakeholders such as farmers, researchers, extension agents, and market actors often interact to achieve common goals. Evaluate the relevance of these interactions by discussing how effective collaboration among stakeholders can enhance agricultural productivity, market access, and sustainability. Use examples to support your evaluation.
5. Imagine you are a farmer in a rural community facing challenges such as low crop yields, limited market access, and outdated farming practices. Using your understanding of the Agricultural Knowledge and Information Systems (AKIS), explain how relying on AKIS can help address these challenges and improve agricultural production in your community.

SECTION

8

GLOBAL WARMING

Agriculture and Climate

Climate Change Variability

INTRODUCTION

This section will introduce you to global warming and its effect on environmental and rural livelihood sustainability. The section explains the meaning, causes, impact and effect of global warming on the environmental and rural livelihood sustainability and ways of controlling the emission of greenhouse gases. Understanding global warming is critical for developing effective strategies to combat climate change and ensure the well-being of ecosystems and human communities. You are expected to have in-depth knowledge of climate policy and international treaties like the Paris Agreement on carbon pricing and national policies to reduce emissions.

KEY IDEAS

- **Climate change** refers to long-term shifts in temperatures and weather patterns.
- **Extreme weather events:** include more powerful hurricanes, prolonged droughts and increased flooding and landslides.
- **Fossil fuel** refers to non-renewable energy sources that are formed from the remains of plants and animals that lived millions of years ago. These include coal, crude oil, natural gas, and petroleum products.
- **Global warming** refers to the long-term increase in the Earth's average surface temperature due to human activities.
- **Greenhouse gases:** refer to chemical compounds in the Earth's atmosphere that trap heat and contribute to climate change.
- **Rural livelihood sustainability:** This is a concern that involves many factors, including climate change, access to resources, and gender.

EFFECT OF GLOBAL WARMING ON ENVIRONMENTAL AND RURAL LIVELIHOOD SUSTAINABILITY

Global warming refers to the long-term increase in the Earth's average surface temperature due to human activities such as burning fossil fuels, deforestation, and industrial processes, primarily causing the emission of greenhouse gases such as carbon

dioxide, methane and nitrous oxide. These gases trap heat in the atmosphere, leading to the greenhouse effect, which causes the planet to warm up. The consequences of global warming include changes in weather patterns; rising sea levels, and impacts on ecosystems and biodiversity.

Causes of Global Warming

It is caused by the increase in greenhouse gas concentrations in the atmosphere due to activities like burning coal, oil, and gas for energy, deforestation, and certain agricultural practices.

Key greenhouse gases and their sources

1. Carbon Dioxide (CO_2): Emitted from burning fossil fuels, deforestation and certain industrial processes and exhausts.
2. Methane (CH_4): Released from human activities such as agriculture (especially livestock rearing), landfills, and fossil fuel extraction.
3. Nitrous Oxide (N_2O): Emitted from agricultural activities, industrial processes, and the burning of fossil fuels.
4. Ozone (O_3): Present in the upper atmosphere (stratosphere) where it forms the ozone layer, but at lower altitudes (troposphere), it can act as a greenhouse gas, being formed by chemical reactions between pollutants.

Consequences of Global Warming on Environmental and Rural Livelihood Sustainability

1. Global temperature rise: Increased greenhouse gas concentrations lead to higher average global temperatures. This rise in temperatures increases heat/warmth in the atmosphere, making life uncomfortable for living organisms.
2. Melting ice and rising sea levels: Warmer temperatures cause polar ice caps, glaciers and ice sheets to melt, contributing to sea level rise and consequent coastal flooding and erosion.
3. Climate change: Global warming leads to altered weather patterns, and increased frequency and severity of extreme weather events (e.g. heatwaves, droughts, storms, floods and hurricanes).
4. Ecosystem disruption: Shifts in climate zones and changing weather patterns impact biodiversity and ecosystems, potentially leading to biodiversity loss and species extinction.
5. Ocean acidification: Increased CO_2 levels lead to higher concentrations of carbonic acid in oceans, affecting marine life.
6. Human health: Increased temperatures and altered weather patterns caused by global warming can directly and indirectly affect human health, such as heat-related illnesses, the spread of diseases and reduced air quality.

Effects of Global Warming on Environmental Sustainability

1. Biodiversity loss: Global warming causes changes in habitats and migration patterns, leading to the decline and extinction of various species e.g. coral bleaching and polar bear population decline.
2. Changes in ecosystems: Altered ecosystems due to global warming can result in imbalanced natural environments, increased wildfires, pests and diseases. Examples: Increased forest fires in California and Australia, and bark beetle infestations.
3. Reduced water resources: Global warming affects the hydrological cycle, causing changes in precipitation (rainfall) patterns, reduced snow cover and melting glaciers, reduced river flows and disappearing rivers and ponds. These affect the availability of fresh water for human and livestock drinking and crop irrigation, particularly in the Sahel region of sub-Saharan Africa.
4. Extreme weather events: Increased frequency and intensity of extreme weather events cause significant environmental damage, e.g. more powerful hurricanes, prolonged droughts and increased flooding and landslides.
5. Agricultural productivity: Global warming raises temperature and reduces precipitation affecting growing seasons, soil fertility and crop yields.
6. Food security: Decreased agricultural productivity and increased extreme weather events due to global warming threaten food security due to shortages and increased food prices. Increased sea acidification and dwindling rivers and ponds cause a decline in fish resources.
7. Livelihoods and income: Decreased productivity and increased food costs reduce household income and economic stability.
8. Migration and displacement: Extreme weather events and deteriorating living conditions and livelihoods force rural populations to migrate. e.g. migration from Bangladesh to India, Malaysia and Singapore, Keta (Volta Region), Nkotompo (Western Region) and communities along the beaches in Ghana, to the hinterland. This movement increases pressure on resources elsewhere.
9. Control of global warming: Controlling global warming requires many approaches involving governments, businesses and individuals to reduce greenhouse gas emissions, increase carbon sinks and implement policies and practices that promote sustainability. These include:

    a. **Reducing greenhouse gas emissions**

        i. **Transition fossil fuels to renewable energy:** Increase the use of solar, wind, hydro and geothermal energy to reduce reliance on fossil fuels that generate greenhouse gases.

        ii. **Energy efficiency:** Improve energy-saving measures in buildings, industries and transportation to reduce energy consumption.

        iii. **Support carbon pricing:** Introduce carbon taxes or cap-and-trade systems to encourage businesses and individuals to reduce their

carbon footprint and emissions. Carbon footprint is the total amount of greenhouse gases, mainly CO2 emitted by human activities.

iv. **Adopt cleaner transportation:** Promote electric vehicles, public transport, biking, and walking to reduce emissions from the transportation sector.

b. Promote sustainable practices

i. **Sustainable agriculture:** Encourage farming practices that reduce methane emissions, such as improving livestock feed and manure management.

ii. **Reduce management:** Implement policies to reduce, reuse and recycle waste to lower methane emissions from landfills.

iii. **Water conservation:** Improve water use efficiency to reduce energy required for water treatment and distribution.

c. Increase carbon sinks

i. **Afforestation and reforestation:** Plant trees and restore degraded forests to absorb carbon dioxide (CO2) from the atmosphere.

ii. **Soil management:** Enact laws to prevent land degradation through surface mining. Adopt agricultural practices that increase carbon storage in soils, such as no-till farming and cover cropping.

iii. **Protect existing forests:** Prevent deforestation and protect existing forests, which act as carbon sinks.

d. Reducing methane and other short-lived climate pollutants

i. **Methane capture:** Methane capture, also known as methane recovery or methane mitigation, is the process of collecting and utilising methane gas that would otherwise be released into the atmosphere.

ii. **Waste management:** Improve waste management practices to reduce methane emissions from organic waste.

e. Supporting climate policy and international cooperation

i. **Support international agreements (Paris Agreement):** Uphold and strengthen commitments to international agreements like the Paris Agreement, which aims to limit global temperature rise and enhance international cooperation on climate action.

ii. **National and local policies:** Governments should create and enforce strong national policies to reduce emissions by promoting renewable energy and energy efficiency mandates and setting emission standards for vehicles and industries.

f. Promoting research and innovation

i. **Climate research:** Invest in research and development of new technologies and practices to improve climate models and understand the impacts of global warming, which can help mitigate global warming.

ii. **Clean technology:** Develop and deploy clean technologies, such as carbon capture and storage (CCS).

g. **Awareness education**

i. **Public education:** Increase public awareness about the causes and consequences of global warming, such as climate change, how individuals can reduce their carbon footprint and promote sustainable practices through education campaigns.

ii. **Climate literacy:** Incorporate climate change education into school curricula to foster a generation of informed citizens.

iii. **Corporate responsibility:** Encourage businesses to adopt sustainable practices and report their environmental impact transparently.

iv. **Community engagement:** Mobilise communities to take action on climate change through local initiatives and sustainable living practices.

h. **Adopt climate-resilient practices**

i. **Climate-smart agriculture:** Implement agricultural practices that are resilient to climate change impacts.

ii. **Urban planning:** Design cities to be more resilient to climate impacts through green infrastructure, sustainable transportation, and efficient energy use.

Activity 8.1: Climate variability and climate change

In pairs, surf the Internet and search for the meaning and causes of global warming. Again, search online for the effects of global warming on your community and discuss your findings among classmates.

Project work

Find a friend and design a project that aims at reducing greenhouse gas emissions into the environment in your locality. Make a presentation to your colleagues in a larger group.

REVIEW QUESTIONS

1. Explain the impact of global warming on your community.
2. Discuss how greenhouse gases trap heat and cause global warming.

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GLOSSARY

A

Accuracy: The closeness of measurements to the true value.

Addition of fertiliser: The application of nutrients to crops to promote growth and increase yield.

Agricultural knowledge: Information related to farming techniques, crop management, and market trends.

AKIS (Agricultural Knowledge and Innovation Systems): A system that integrates knowledge from research, extension, and farmers to improve agricultural practices.

Arable crop: Crops grown on ploughed land, such as cereals, legumes and tubers.

B

Biofuel: A class of renewable energy derived from living materials (biomass).

C

Calibration: Adjusting machinery to ensure accurate application of inputs like water or chemicals.

Capacity building: Activities designed to enhance the skills and knowledge of farmers, traders, and processors.

Coal: a combustible black or brownish-black sedimentary rock with a high amount of carbon and hydrocarbons.

Collaboration: Working together among stakeholders to improve agricultural practices and outcomes.

Control group: A group in an experiment that does not receive the treatment.

CPR (Cardiopulmonary Resuscitation): A life-saving technique

D

Data: information collected during an experiment.

Drones: Unmanned Aerial Vehicles (UAVs) used for crop monitoring, mapping, and precision agriculture.

Drought: a prolonged period of abnormally low rainfall leading to a shortage of water.

Drying: Reducing the moisture content in harvested crops to prevent spoilage.

E

Emissions: an amount of substance that is produced and sent out into the air that is harmful to the environment.

Entrepreneurship: Skills to establish and manage profitable animal production ventures.

Extension services: Programmes that provide farmers with advice and practical knowledge on agricultural practices.

F

Fertiliser application: Adding nutrients to soil to promote healthy plant growth.

Financial support: Assistance in the form of loans, grants, or subsidies to enable agricultural production and expansion.

First Aid: Initial care given to an injured person.

Flooding: the covering or submerging of a normally dry land with a large amount of water.

Foliar Fertiliser: A liquid fertiliser applied directly to plant leaves for nutrient absorption.

G

Geographic Information Systems (GIS): Software analysing and displaying geospatial data, helping farmers manage land and resources.

Global Positioning Systems (GPS): A network of satellites providing location information, used in agriculture for precision farming.

Grading: The sorting of unlike lots of produce into different lots according to the quality

specifications laid down.

H

Harvesters: machines or tools used for gathering crops.

Harvesting: The process of collecting mature crops from the field.

Hurricane: a storm with violent winds.

Hydrocarbons: an organic compound that consists of carbon and hydrogen only.

Hygrometer: A device measuring humidity.

Hypothesis: An educated guess or assumption made before experimenting.

I

Income generation: Activities aimed at producing financial resources through animal production.

Innovation: New methods, technologies, or processes that improve agricultural productivity and sustainability.

Interoperability: The ability of different systems, tools, or devices to work together effortlessly.

Irrigation: Supplying water to crops during dry periods to ensure optimal growth.

K

Knapsack sprayer: A portable sprayer used for applying pesticides or fertilisers.

L

Land preparation: Activities like clearing, ploughing, and levelling the field for planting.

Landfill: a site for the disposal of waste materials.

Landslide: a collapse of a mass of mass of earth.

Livelihood development: Improving living conditions through productive activities like animal farming.

Livelihood: the activities and resources that a person or household needs to secure the necessities of life, or the daily tasks people perform to earn a living

Lubrication: Applying oil or grease to moving parts to reduce friction.

M

Machinery: Tools or equipment used to perform agricultural tasks more efficiently.

Maintenance: Routine actions taken to keep machinery in good working condition.

Market linkages: Connections between producers and buyers to ensure access to profitable markets.

Market needs: Demand for specific crops based on consumer preferences and market trends.

Market survey: Process of gathering information about crop demand, prices, and competition.

Marketing: Strategies to promote and sell animal products effectively.

Markets: Platforms where animal products are bought and sold.

Mini-setts: These are pieces of cut yam tubers, typically weighing about 25-50 g each with at least one bud (eye) which can sprout and grow into a new plant.

Multifaceted: Having many different aspects or features/ having many sides.

N

Nursery: A controlled environment for growing young plants until they are ready for transplanting.

P

Packaging: The act of protecting or enclosing, or preserving agricultural products for distribution, storage, sale and use.

Pest control: Managing pests through chemical or natural methods to protect crops.

pH Meter: A device measuring soil acidity or alkalinity.

Planting: The act of placing seeds or seedlings in the soil for growth.

Policy advocacy: Efforts by organisations to influence agricultural policies for better outcomes for farmers and the agricultural sector.

Post-harvest: The stage after crop harvesting, focusing on handling, storage, and processing.

PPE: Personal protective equipment is used to ensure safety while operating machinery to prevent injury.

Precision: the consistency of measurement.

R

Resources: Inputs required for animal production, such as feed, shelter, and breeding stock.

S

Safety precautions: Guidelines followed to prevent accidents when using machinery.

Seed selection: Choosing high-quality seeds suitable for specific soil and climate conditions.

Small ruminants: Livestock like sheep and goats are reared for meat, milk, wool or hides.

Snail rearing: Cultivating snails for food and income through controlled environments.

Soil pH: It refers to the degree of acidity or alkalinity in the soil

Soil preparation: The process of getting soil ready for planting through tilling or ploughing.

Soil sensors: These are devices that measure soil conditions like moisture, temperature, and nutrient levels to optimise crop growth.

Soil testing: Checking soil nutrients and pH before planting to ensure crop suitability.

Sprain: Injury to ligaments.

Sprouting: The initial growth stage of yam tubers, where shoots emerge from the eyes or buds.

Stakeholders: Individuals or groups involved in the agricultural value chain, including farmers, traders, processors, and support agencies.

Staking: Supporting plants with stakes to promote healthy plant growth.

Storage: Safely keeping harvested crops to maintain quality and prevent losses.

Storm: a violent disturbance of the atmosphere with strong winds and usually rain, thunder, and lightning.

Strain: Injury to muscles.

Support organisations: Groups that assist stakeholders (farmers, traders, processors) with services like funding, training, and market access.

Sustainability: Practices ensuring long-term productivity while minimising environmental impacts.

T

Target market: A specific group of consumers interested in buying arable crops.

Thermometer: A device measuring temperature.

Threshing: Separating grains or seeds from the harvested crop.

Transplanting: Moving seedlings from a nursery to a larger field or garden.

Treatment group: A group in an experiment that receives the treatment.

Tubers: Underground plant stems or roots that produce edible storage organs (eg yams, potatoes)

V

Value addition: Processing crops into products like flour or packaged grains to increase market value.

Value chain: The series of steps involved in producing and marketing a commodity, from raw material to finished product.

Variable: A factor that can be changed or controlled in an experiment.

Variable Rate Technology (VRT): Equipment applying varying amounts of inputs (seeds, fertilisers, etc) based on soil types and crop needs.

W

Weeding: Removing unwanted plants that compete with crops for nutrients and water.

Y

Yield: The amount of crops produced from a given area of land.

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