MINISTRY OF EDUCATION

AGRICULTURAL SCIENCE

for Senior High Schools

TEACHER MANUAL

YEAR TWO

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

MINISTRY OF EDUCATION

REPUBLIC OF GHANA

AGRICULTURAL SCIENCE

For Senior High Schools

Teacher Manual

Year Two

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

AGRICULTURAL SCIENCE TEACHER MANUAL

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Introduction

The National Council for Curriculum and Assessment (NaCCA) has developed a new Senior High School (SHS) curriculum which aims to ensure that all learners achieve their potential by equipping them with 21st Century skills, competencies, character qualities and shared Ghanaian values. This will prepare learners to live a responsible adult life, further their education and enter the world of work.

This is the first time that Ghana has developed an SHS 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.

This Teacher Manual for Agricultural Science is a single reference document which covers all aspects of the content, pedagogy, teaching and learning resources and assessment required to effectively teach Year Two of the new curriculum. It contains information for all 24 weeks of Year Two including the nine key assessments required for the Student Transcript Portal (STP).

Thank you for your continued efforts in teaching our children to become responsible citizens.

It is our belief that, if implemented effectively, this new curriculum 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.

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SECTION 1: SCIENTIFIC EXPERIMENTAL PROCEDURE AND SAFETY IN AGRICULTURE

Strand: New Dawn Agriculture

Sub-Strand: Misconceptions and Prospects in Agriculture and Farming

Learning Outcomes

1. *Use the knowledge and skills acquired to conduct simple agricultural science experiments*
2. *Use the knowledge and skills acquired in measurements to assess environmental factors and physical parameters in agricultural production*
3. *Use the knowledge and skills acquired to observe the necessary safety measures and administer First Aid during agricultural accidents*

Content Standards

1. *Demonstrate knowledge and understanding of the meaning and relevance of the scientific procedure in Agricultural Science.*
2. *Demonstrate knowledge, understanding and skills of measurements, measuring tools and their uses in agricultural production.*
3. *Demonstrate knowledge and understanding of the meaning and importance of safety and First Aid in agricultural production.*

Hint

- *Assign learners their portfolio task in week 2.Refer to Appendix B for sample portfolio assessment to be submit in week 23.*
- *Assign learners the Group Project by Week 4 to be submitted by Week 9. Refer to Appendix D and the Teacher Assessment Manual and Toolkit page 27 for additional information on how to go about the project.*

INTRODUCTION AND SECTION SUMMARY

This section introduces learners to the scientific procedure and safety in Agricultural Science. It highlights the meaning, key components and relevance of the scientific experimental procedure; simple scientific measuring tools and basic parameters and their calculations; safety measures and first aid in agricultural production. The scientific experimental procedure is fundamental to advancing knowledge in Agricultural Science. It provides a framework for testing ideas, validating practices and discovering new solutions to agricultural challenges. The section also aims to help learners develop basic skills in using simple measuring tools to

determine basic parameters in agricultural production. Learners are also expected to have in-depth knowledge about safety measures and proper ways of administering first aid during emergencies.

The weeks covered by the section are:

Week 1

a. The meaning and relevance of scientific experimental procedure in Agricultural Science.

b. Scientific experimental procedures in Agricultural Science

Week 2: Measuring instruments used in agricultural production

Week 3: Simple scientific measuring tools for assessing parameters in agricultural production.

Week 4: Safety in operating farm machines in agricultural production.

Week 5: First aid in agricultural production.

SUMMARY OF PEDAGOGICAL EXEMPLARS

The relevance of using appropriate pedagogy in teaching and learning cannot be overstated. The use of proper pedagogies enhances the quality of learning hence learners are well-prepared to meet future challenges. Modern pedagogies that enable learners to develop 21st-century skills such as digital literacy, critical thinking and collaboration, will be used to prepare learners for future opportunities. Pedagogies that encourage active learning, such as project-based, enquiry-based, problem-based and experiential learning will be used to teach scientific experimental procedures to promote critical thinking and problem-solving skills. These skills are essential for learners to deal with complex real-world challenges. The section deploys structured talk for learning, think-pair-share, digital and collaborative learning in teaching safety measures and first aid in agricultural production to address the diverse needs of learners, including those with different cultural backgrounds and learning abilities. This inclusivity ensures that all learners have equal opportunities to succeed.

ASSESSMENT SUMMARY

The correct assessment strategies ensure accurate measures of learners' performances, improve instructional practices, support learners' growth and promote equity and inclusion. The section uses diverse assessment strategies to provide a comprehensive evaluation of learners' performance across the different instructional strategies. These include both formative and summative assessment strategies to provide ongoing feedback to learners, helping them identify their strengths and areas for improvement. The assessment considers the various levels of learner proficiency and the expected depth of knowledge. It includes class exercises and tests, assignments, project-based work and demonstration of skills while responses can be either oral or written and presented by individuals or groups. Teachers are expected to give prompt feedback to learners on their performance and record their performances in class exercises, tests and project works in the transcript system.

Week 1

Learning Indicators

1. *Explain the meaning and relevance of scientific experimental procedure in Agricultural Science*
2. *Outline the scientific experimental procedure in Agricultural Science*

Focal Area 1: The meaning and relevance of scientific experimental procedure in Agricultural Science

Definition of Scientific Experimental Procedure: Scientific experimental procedure is a series of steps used to investigate research questions, test hypotheses and draw relevant conclusions that help understand and explain or answer the questions and hypotheses stated.

Relevance of the experimental procedure in Agricultural Science

1. **Enhanced crop and livestock production:** Scientific experiments generate relevant information that helps develop and optimise agricultural practices, such as improving crop yields, pest and disease management, soil fertility and animal husbandry practices.
2. **Sustainable production:** Scientific research develops sustainable farming practices for long-term productivity.
3. **Reduced negative environmental impact:** Scientific research develops production systems that minimise negative environmental impact and help conserve natural resources.
4. **Food security:** Scientific research helps improve food production systems, contributing to global food security by ensuring a stable and sufficient food supply.
5. **Innovations and technological advancements:** Scientific experimentation produces new agricultural technologies, such as genetically modified crops, advanced irrigation systems and precision farming tools and strategies.
6. **Sound policy and decision-making:** Reliable experimental data guides policymakers in creating informed regulations and policies related to agriculture, food safety, and environmental protection.
7. **Adaptation to climate change:** Scientific experiments investigate the effects of climate change on agriculture, helping develop strategies for crop resilience and adaptation to changing environmental conditions.
8. **Total character formation:** Scientific research/experimentation encourages critical thinking and digital literacy and improves writing skills and good interpersonal relationships. It also research and report writing teaches individuals to be objective, fair and honest.

Learning Tasks

1. Learners explain the meaning of scientific experimental procedures in Agricultural Science.
2. Learners outline the key components of the scientific experimental procedure in Agricultural Science
3. Learners discuss the relevance of scientific experimental procedure in Agricultural Science

Pedagogical Exemplars

1. **Structured talk for learning:** In groups, learners brainstorm the meaning of scientific experimental procedures in Agricultural Science and discuss their findings with their group members. The teacher should guide learners with probing questions and encourage the shy and introverted to contribute to and lead some of the discussion.
2. **Enquiry-based learning:** The teacher asks learners to identify the key components of performing a scientific experiment. Learners in their groups identify the key components. The teacher should guide and support learners with leading questions to outline the scientific process. Learners discuss their findings and present them in flow charts.
3. **Think-Pair-Share:** In pairs, learners discuss the relevance of scientific experimental procedures in Agricultural Science and share their findings with their peers.

Key Assessment

Assessment Level 1: Explain the meaning of a scientific experiment in Agricultural Science.

Assessment Level 2: Discuss three key components of the scientific experimental procedure in Agricultural Science.

Assessment Level 3: Examine the relevance of scientific experimental procedure in Agricultural Science.

Focal Area 2: Scientific experimental procedure in Agricultural Science

The scientific experimental procedure in Agricultural Science involves investigating agricultural questions, testing hypotheses and developing new techniques or products. These procedures help ensure findings are valid, reliable and applicable. Here are the detailed steps to follow:

1. **Identify the research problem:** Scientific experiments begin with identifying a research problem or topic. This can be done by critically observing the crop, animal, or environment for factors like appearance, yield, pest infestation, diseases, or soil degradation.
2. **Decide the experimental treatments and variables**
    a. Treatments are the factors whose effects will be investigated.
    b. Variables come in three forms i.e. Independent, dependent and controlled.
        i. The independent variable (Treatment) is the factor that the experimenter can vary (e.g. type or rate of fertiliser).

   ii. The dependent variable is the factor that is measured to assess the effect of the treatment (e.g. leaf size, crop yield).
   iii. Controlled variable: Factors that are fixed by the experimenter or remain naturally constant (e.g. water supply, sunlight, temperature, soil type).

3. **Design the experiment**
   a. Experimental plan: Outline the methodology including 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 e.g. it gets no fertiliser. This allows a comparison of an area that gets fertiliser with an area that gets no fertiliser and enables the effect of the fertiliser to be seen and measured.
   c. Include a check: A treatment that is the recommended amount of the independent variable
   d. Replication: Repeat all treatments at least three times to ensure data reliability.
   e. Randomization: Randomly assign treatments to plots in the different replications to minimise confounding treatment effects and reduce bias.
   f. Assemble materials e.g. seeds, fertilisers and measuring tools required for the experiment
4. **Prepare the experimental site:** This could be in the laboratory, greenhouse, field plots or farmers' fields.
5. **Experimental layout:** Layout the experiment according to the design and apply treatments as specified.
6. **Data collection:** Collect data systematically, using acceptable methods and record observations accurately.
7. **Data interpretation (Results)**
   a. Summarise the findings, identifying trends or patterns. Data may be organised into tables, charts, or figures.
   b. Determine whether the results support or refute the hypothesis.
   c. Compare the findings to, or discuss the findings in light of, existing research and theoretical expectations.
8. **Conclude**
   a. State the important findings from the research.
   b. Indicate the practical implications and applications of the findings for agriculture and any recommendations for farmers or stakeholders.
   c. Highlight any limitations of the study and suggest areas for further research.
9. **Report findings:** Write a detailed report including all aspects of the experiment: introduction, literature review, materials and methods, results, discussion and conclusion with recommendations.
10. **Repetition:** Repeat the experiment at different locations simultaneously or during different seasons to enhance the credibility of the results

Example of 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 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.

Learning Tasks

1. Learners to identify the stages involved in conducting scientific experiments in Agricultural Science.
2. Learners to discuss the stages involved in conducting scientific experiments in Agricultural Science with relevant examples
3. Learners perform a simple scientific experiment on a problem assigned to them by the teacher and write a report to present to the class.

Pedagogical Exemplars

1. **Digital learning:** Learners, in groups, watch a video documentary of a scientific experiment. The teacher guides learners with leading questions to deduce the steps involved in experimenting.
2. **Collaborative learning:** Learners in groups, discuss the steps involved in performing the scientific experiment. Teacher should support learners with relevant examples and encourage all learners to be involved in the discussion.
3. **Project-based learning:** Teachers should put learners in mixed ability groups and assign each group to design a simple research problem in agriculture and present their results to the class. The more gifted learners should lead and support the less endowed.

Key Assessments

Assessment Level 1: List the stages to go through a scientific experiment.

Assessment Level 2: Explain experimental design in scientific experiments.

Assessment Level 3

1. Discuss the importance of data collection and conclusion in scientific experiments.
2. Outline and discuss the procedure of scientific experiment in agricultural science.

Hint

*The recommended mode of assessment for week 1 is **discussion**. Use the level 3 question 2 as a sample question.*

Week 2

Learning Indicator: Outline the uses of measuring instruments in agricultural production

Focal Area 1: Measuring instruments used in agricultural production

Simple scientific measuring instruments for assessing parameters in agricultural production

Various simple measuring instruments/tools are used to assess different parameters in agricultural production. These tools help farmers and researchers gather data for decision-making and optimising farming practices. Below are some scientific measuring tools commonly used in agriculture

1. **Soil pH meter:** This is used to measure the acidity or alkalinity of the soil. Determination of soil pH is crucial for determining soil fertility and the availability of nutrients to plants.
2. **Chlorophyll meter**
    a. Chlorophyll meters are used to measure the chlorophyll content of plant leaves, and detect stress, leading to better nutrient and plant health management and predicting crop productivity.
    b. Nitrogen management: Chlorophyll meters assess the nitrogen status of plants. Nitrogen is a key component of chlorophyll. Its deficiency or excess can be detected through changes in chlorophyll content.
    c. Fertiliser optimisation: By providing real-time data on plant nitrogen levels, chlorophyll meters assist farmers in optimising fertiliser applications, leading to cost savings and reduced negative environmental impacts.
3. **Soil tensiometer:** A soil tensiometer is an instrument used to measure the soil water tension, which indicates the moisture content and availability of water to plants. This tool is essential for effective irrigation management and understanding soil-water-plant interactions.
4. **Nitrate test strips:** Nitrate test strips are simple and effective tools used to measure the concentration of nitrate ions (NO) in water, soil, and plant tissues.
5. **Weighing scales (balances):** They are essential tools used in agriculture for measuring the mass or weight of objects and substances in grams (g), **kilograms (Kg) or pounds (lbs)**. In agriculture, weighing scales are commonly used for the following
    a. weigh harvested crops to determine yield.
    b. monitor the weight of livestock for health assessments, breeding and sale.
    c. measure the weight of feed to ensure proper nutrition for animals.

Figure 2.1

6. **Vernier callipers:** Vernier callipers are precision measuring instruments that accurately measure linear dimensions, depths and diameters. The primary graduation is in millimetres but some callipers also have centimetre markings for reference.
7. **Soil thermometer:** A soil thermometer is a tool used to measure the temperature of soils at varying depths. Soil temperature is a critical factor in agricultural and horticultural practices, as it influences seed germination, plant growth, microbial activity and nutrient availability.
8. **Rain gauge:** Rain gauges are instruments for measuring the amount of precipitation over a specific period at a particular location. The amount of rainfall in a specific area, measured in millimetres (mm), directly determines crop growth.
9. **Leaf area metre:** A leaf area metre 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 critical parameter in plant growth analysis. Leaf area is a significant predictor of crop yield. Farmers and agronomists use leaf area data to estimate potential crop yields and make informed decisions about resource allocation. Monitoring changes in leaf area can help detect diseases and pest infestations early, allowing for timely interventions.
10. **Anemometer:** It measures wind speed and direction, which are important factors for pesticide and liquid fertiliser application, to reduce drifts, particularly to unwanted areas.

Figure 2.2

11. **Air thermometer:** Air thermometers play a crucial role in agriculture by providing temperature measurements that are essential for various aspects of crop management, livestock care and overall farm operations. Temperature is measured in either Fahrenheit (^{0}F) or Celsius (^{0}C).

Agricultural applications of thermometers

a. **Timing of planting:** Temperature data helps farmers determine the optimal planting time, particularly in temperate and hot dry zones. Certain crops require specific temperature ranges for germination and early growth.

b. **Micro-climate control:** Optimal temperatures are critical for plant health and productivity in greenhouses. Thermometers help monitor and regulate the internal climate, ensuring it stays within desired ranges.

c. **Disease prevention:** Proper temperature regulation in enclosed environments such as silos, warehouses and cold rooms, can prevent the proliferation of pests and diseases, which often thrive in specific temperature conditions.

d. **Health monitoring:** Special thermometers are used to monitor the body temperature of livestock and humans, helping detect illnesses early. Abnormal temperatures can indicate infections or other health issues.

12. **Syringes:** Syringes are essential tools in animal production, used by farmers and veterinarians to administer medications, vaccines and other substances to animals, protecting them from diseases.
13. **Soil moisture meter:** Measures the moisture content of soils thus helping to optimise irrigation scheduling and prevent overwatering or underwatering.
14. **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).
15. **Drenching guns:** Drenching guns are special devices used to administer oral medications to livestock. The guns are designed for livestock such as cattle and small ruminants.
16. **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 2.3

17. **Beakers:** They are used for measuring liquids in the laboratory. Beakers have volume markings to 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.
18. **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.

Learning Tasks

1. Learners to make a list of measuring tools used in agriculture.
2. Learners to discuss the uses of specific agricultural measuring tools.
3. Learners to discuss the precautionary measures to ensure accurate measurements when using the measuring tools.

Pedagogical Exemplars

1. **Think-pair-share:** Learners individually list examples of agricultural measuring tools and instruments and their use(s) and share them with a peer. Teachers should encourage cooperation among learners.
2. **Experiential learning:** Teacher assembles measuring tools available (measuring cylinders, beakers, rules/tape measures, weighing scales, pH meters, thermometers, anemometers, rain gauges, Vernier callipers) for identification by learners. Pictures can be provided where the real objects are not available.
3. **Collaborative learning:** Learners in groups, discuss the uses of agricultural measuring tools and make presentations to the class.
4. **Structured talk for learning:** Learners in groups, discuss the necessary precautionary measures that ensure accurate measurements when using the measuring tools and present their findings to the class. Teachers should use probing questions to guide learners in identifying the precautions. More confident learners should be encouraged to lead and assist their peers.

Key Assessments

Assessment Level 1: List five measuring tools used in agriculture

Assessment Level 2:

1. Outline the main uses of thermometers, anemometers, rain gauges and Vernier callipers in agricultural production.
2. Outline the uses of ten (10) measuring instruments used in agricultural production.

Assessment Level 3: Discuss four precautions that ensure accuracy when using agricultural measuring tools.

Hint

- *The recommended mode of assessment for week 2 is homework. Use the level 2 question 2 as a sample question. See Appendix A*
- *Assign learners their portfolio task in week 2. Refer to Appendix B for sample portfolio assessment to be submit in week 23.*

Week 3

Learning Indicator: Demonstrate simple scientific measuring tools to assess parameters in agricultural production

Focal Area 1: Simple scientific measuring tools for assessing parameters in agricultural production

Basic parameters measured in agricultural production and their calculations

Various parameters are assessed for productivity, efficiency and quality in agricultural production. These parameters can vary depending on the crop, livestock, or farming method. Here are some basic parameters commonly measured in agricultural production, along with brief explanations of how they are calculated

1. **Temperature:** Temperature is measured in degrees Celsius (°C) or Fahrenheit (°F) using thermometers. Use a thermometer suitable for the specific purpose (e.g. rectal thermometer for animals). Place the thermometer in the appropriate location (e.g. rectum or mouth) and wait for the reading to stabilise to measure body temperature accurately. Other parameters are air temperature and soil temperature.
2. **Relative humidity:** This is the amount of water vapour in the air compared 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.
3. **Area of a vegetable bed:** This is the product of the length and width of the bed using a measuring tape or distance measuring wheel.

   Formula: Area = Length x Width
4. **Plant height:** Measuring tapes are used to determine plant height in centimeters or inches. This is done regularly to observe changes in height.
5. **Growth and development:** Growth is the increase in height, girth, spread and weight, while development is the change in complexity due to the addition of new tissues and structures. Plant growth is assessed by determining the fresh or dry weight regularly. Weighing scales and ovens are used to weigh and dry the plant materials. The oven temperature is kept between 40^0 and 70^0C during the drying process. Where destructive sampling cannot be done, standard growth stage scales for specific crops are used to estimate growth.
6. **Plant population density:** This is determined by dividing the total area to plant, by the product of the inter-row and intra-row spacing, then multiplying 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).
7. **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 productivity of the farming system. Tools for measuring yield are the measuring tape (to determine the area of the land) and the weighing scale, for measuring the weight of produce. 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 = $\frac{\text{Quantity of product harvested (Kg) x 10,000 (m}^2\text{)}}{\text{Unit of land area (m}^2\text{)}}$

8. **Hen day egg production:** Count the number of eggs laid by a group of hens in a specific period e.g. one day of 24 hours. Divide the total number of eggs by the number of birds to determine 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.
9. **Feed conversion efficiency (FCE):** Measure the amount of feed consumed by animals (feed intake). Measure the weight gain of the animals over a specific period. Divide the feed intake by the weight gain to calculate the feed conversion efficiency.
10. **Heart rate:** Locate the pulse point in the animal (e.g. by palpating the femoral artery in large animals or feeling the heartbeat through the chest in smaller animals). Count the number of heartbeats within a specific time frame (e.g. one minute) to determine the heart rate. In the case of humans, learners can detect the pulse on the wrist or the anterior side of the ear of their colleagues.
11. **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.
12. **Dressing percentage of carcass:** Measure the live weight of the animal and then the dressed carcass weight (after removing feathers, internal organs, blood and skin). Divide the dressed carcass weight by the live weight and multiply by 100 to determine the dressing percentage.
13. **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.
14. **Stocking rate (Ruminants):** This depends on the land area available. Divide the total area by the recommended area per animal (based on species and desired stocking density) and multiply the result by 100 to determine the stocking rate.
15. **Soil nutrients:** This includes nitrogen (N), phosphorus (P), potassium (K) and other essential nutrients (e.g. calcium, magnesium). Soil nutrient levels are determined using soil testing kits and nutrient analysis instruments.
16. **Soil pH:** pH is a measure of the acidity or alkalinity of a solution. 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.
17. **Soil moisture:** Soil moisture is measured as the percentage of water content using soil moisture meters or sensors. Determining soil moisture content is crucial in agricultural and environmental sciences to understand water availability to plants, soil health and irrigation management.

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

Materials Needed

a. Soil sample
b. Weighing balance

c. Moisture cans (metal containers)

d. Oven (capable of maintaining 105-110°C)

e. Desiccator

f. Tongs or gloves (to handle hot containers)

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

Procedure

a. Sample collection: Collect a representative soil sample from the field using an auger or an earth chisel. Reach to at least 15 cm below ground level. Collect several samples from different parts of the field and combine them before taking sub-samples. Ensure the sample is stored in an airtight container to prevent moisture loss.

b. Weighing the soil sample

   i. Clean and dry a moisture can.

   ii. Weigh the empty moisture can using the weighing balance and record its mass (W_1).

   iii. Place a sample of the soil in the moisture can. Typically, 20-30 g of soil.

   iv. Weigh the moisture can with the soil and record its mass (W_2).

c. Drying the soil sample

   i. Place the moisture can with the soil sample into the oven.

   ii. 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.

d. Cooling the sample

   i. After drying, remove the can from the oven using tongs or gloves.

   ii. Place the can in a desiccator to cool to room temperature. This prevents the absorption of moisture from the air during cooling.

e. Weighing the dry sample: When cool, weigh the can with the dried soil and record its mass (W_3).

f. Calculation

   i. Determine the Mass of Water: $W_{water} = W2 - W3$

   ii. Determine the Mass of Dry Soil: $W_{dry\ soil} = W3 - W1$

   iii. Calculate the Moisture Content:

$$\text{Moisture Content} = \left(\frac{W_{water}}{W_{dry\ soil}} \right) \times 100$$

Sample calculation

Assume the following recorded masses

Mass of empty can (W_1) = 50 grams

Mass of can + wet soil (W_2) = 80 grams

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

a. Mass of water (W_{water}) = 80 – 70 =10 grams

b. Mass of dry soil ($W_{dry\ soil}$) = 70 – 50 = 20 grams

c. Moisture Content (%) = $\frac{10}{20} \times 100 = 50\%$

Note

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

g. Interpretation and application of result

i. Compare moisture content values among soil samples or depths to understand variability.

ii. Use the results to assess soil water availability, determine irrigation needs, or evaluate soil health.

18. **Pest and disease assessment:** This includes the presence and severity of pests (insects, weeds, pathogens) and diseases. Measurement is done by visual observation, pest traps, and disease assessment or scoring based on symptoms.
19. **Water quality:** Water quality is assessed based on pH, electrical conductivity (EC), dissolved oxygen (DO), and nutrient levels.
20. **Weather conditions:** Parameters include precipitation (dew, rain and snow), humidity, wind speed, and solar radiation. Weather data is collected using weather stations equipped with sensors for measuring these parameters. Tools 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).
21. **Agri-input use:** Agri-input use, particularly fertilisers and pesticides, is paramount in food production. The essential aspects to consider include the amount and timing of the input applications. Fertiliser amounts are based on recommended rates, and weighed with electronic scales or calibrated scoops, while pesticide amounts and rates are determined with either pipettes, measuring cylinders or graduated caps.
22. **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.
23. **Efficiency parameters:** These measure how effectively resources (such as water, fertilizer or energy) are used in agricultural production e.g. 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.

24. **Costs and returns:** These rely on costs incurred and returns generated from agricultural production e.g. total cost of production includes expenses for inputs like seeds, fertilisers, pesticides, labour and machinery. Returns are the revenue generated from selling agricultural products. Profitability is often assessed by comparing returns to costs.
25. **Environmental impact:** The effects of agricultural production on the environment e.g. air quality deterioration, 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.

Learning Tasks

1. Identify and list instruments or tools for measuring some basic parameters in agricultural production.
2. List the parameters that are measured in agricultural production.
3. Perform simple experiments to measure some basic parameters in agricultural production.
4. Calculate the various parameters used in agricultural production.

Pedagogical Exemplars

1. **Experiential learning**
    a. Teacher/instructor/technician demonstrates measurements in the laboratory and field using the measuring instruments provided.
    b. Learners use the instruments in class/laboratory/field to measure the various parameters and record their observations.
    c. Learners take note of variations in their measurements and observations, discuss them and make inferences concerning human differences. Visually challenged learners should be provided with magnifying glass to easily determine liquid levels and markings on graduated implements.
    d. Teacher guides learners to determine soil moisture content in the laboratory.
2. **Collaborative learning:** Learners in mixed-ability groups watch videos/pictures on the appropriate uses of the scientific measuring tools and instruments unavailable in their laboratories and discuss their observations.

Key Assessments

Assessment Level 1: List four instruments or tools for measuring some basic parameters in agricultural production.

Assessment Level 2: Explain the importance of determining the pH of a soil.

Assessment Level 3: Compare the parameters for estimating plant population density and crop yield.

Assessment Level 4

1. Some soil was placed in a can. The can weighed 60 g with the soil and 10 g when empty. The can with its content was heated until a constant weight of 40 g was obtained. Determine the percentage moisture content of this soil.
2. Demonstrate how you will use simple scientific measuring tools to determine parameters in agricultural production like determination crop yield of a given area of land.

Hint

The recommended mode of assessment for week 3 is demonstration. Use the level 4 question 2 as a sample question. Refer to Appendix C for information on the demonstration and a rubric to mark learners.

Week 4

Learning Indicator: Describe the safety measures employed in operating farm machines in agricultural production

Focal Area: Safety in operating farm machines in agricultural production

1. **Safety measures employed in operating farm machines and power tools**

The safe operation of farm machines is crucial to preventing accidents and injuries. Here are some safety measures that should be employed

a. Training and education

i. Ensure all operators receive comprehensive training on how to use each machine.
ii. It is important to read and understand the operator's manual for each piece of equipment.

b. Pre-operation inspection routines

i. Inspect machines before use to ensure they are in good working condition.
ii. Verify that oil, fuel and other fluid levels are adequate before starting the engine.
iii. Check the tyre pressure and the condition of the brakes before moving the machine.
iv. Keep a first aid kit accessible and have emergency contact numbers readily available.

c. Use of personal protective equipment (PPE)

i. Wear close-fitting clothing to avoid entanglement with moving parts of machines.
ii. Wear protective gear such as gloves, safety glasses, earbuds and boots when operating farm machines.

d. Proper behavioural practices

i. Do not use mobile phones or other distractions while operating machinery.
ii. Take regular breaks to avoid fatigue and prevent accidents.
iii. Do not operate machinery under the influence of drugs or alcohol.

e. Safe operational practices

i. Ensure the work area is free of obstructions and hazards before operating machines.
ii. Keep bystanders, especially children, away from running machines and equipment.
iii. Avoid operating on steep slopes or uneven terrain to prevent rollovers.
iv. Turn off the engine before performing any maintenance or adjustments.

f. Machine-specific safety measures

i. Use rollover protective structures (ROPS) and seat belts when operating farm machines.
ii. Stay clear of moving parts of combine harvesters and keep shields in place when using them.

iii. Do not attempt to clear blockages while fodder balers are running.

iv. Keep power take-off (PTO)shields in place and avoid loose clothing that can get caught on the tractor.

g. Proper environmental considerations

i. Ensure adequate lighting for operations early in the morning or late in the evening.

ii. Avoid operating machinery during adverse weather conditions like heavy rainfall.

h. Technology and innovations

i. Use machines equipped with safety sensors and automatic shut-off systems.

ii. Employ GPS and automated systems to reduce human error and enhance precision.

i. Regular maintenance and repairs

i. Perform regular maintenance according to the manufacturer's recommendations.

ii. Ensure repairs are conducted by qualified personnel.

iii. Use lockout/tagout procedures to ensure machines are not started accidentally during maintenance.

j. Safe handling of chemicals and fuels

i. Store chemicals and fuels in the appropriate, clearly labelled containers and away from ignition sources.

ii. Use proper procedures to handle spills and leaks to prevent accidents and environmental contamination.

2. **Importance of observing safety measures when operating farm machines and power tools**

a. Safety measures like proper training, use of PPE and adherence to safety protocols help to prevent accidents.

b. Proper training and safety measures ensure that workers can respond effectively to emergencies, reducing the potential impact of accidents.

c. Implementing safety measures reduces the liability of farm owners and operators in the event of an accident.

d. Proper maintenance and safety checks ensure that machines function correctly, reducing the likelihood of accidents due to mechanical failures.

e. Preventing accidents reduces medical expenses and costs associated with workers' compensation.

f. Complying with safety regulations minimizes legal action and associated costs due to workplace accidents.

g. Regular maintenance and safety checks prolong the lifespan of machinery and ensure efficient operation.

h. A safe working environment boosts worker confidence and morale, leading to higher productivity and better job satisfaction.

i. 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

Figure 4.1: *Protective overall*

Figure 4.2: *Goggles for protecting the eyes*

Figure 4.6: *Rubber hand gloves*

Figure 4.7: *Local straw hat for working in the sun*

Figure 4.4: *Head protecting helmet*

Figure 4.5: *Wellington boots for working in the field Figure 4.6: Rubber hand gloves*

Figure 4.8: *Man wearing full protective gear while spraying pesticide*

Figure 4.3: *Nose shield for pesticide application*

Learning Tasks

1. Explain safety measures employed in operating farm machines.
2. Discuss examples of PPE used in agricultural production
3. Demonstrate the correct usage of PPE in agricultural production.
4. Examine the importance of employing safety measures in operating farm machines.

Pedagogical Exemplars

1. **Problem-based learning:** In mixed-ability groups, learners brainstorm examples of safety measures for agricultural activities. The teacher should use videos/pictures to guide learners to identify the safety measures for agricultural activities. The teacher should ensure that the videos used are not gender biased.
2. **Experiential learning:** Learners in their groups visit a farm machinery workshop or watch videos/pictures of activities carried out at a farm site/machinery workshop and discuss the safety measures that reduce or prevent injuries. The teacher should ensure that all the safety protocols are strictly applied at the workshop. Learners should be guided with probing questions to list other safety measures not observed at the machinery workshop or in the video.
3. **Experiential learning:** Learners, perform a farm activity such as bed preparation or fertiliser application and demonstrate the safety measures before and during the activity. All learners should be encouraged to participate in the activity. Learners who have difficulties in performing the activities should be assisted.
4. **Structured talk for learning:** Learners in their groups discuss the importance of observing safety measures during farm activities or operating farm machines and make presentations to the class. The teacher guides learners with leading questions to help them identify the importance of observing safety measures in agricultural production. Learners with prior knowledge and experience should guide the others.

Key Assessments

Assessment Level 1: State two farm operations and their appropriate PPE.

Assessment level 2: Explain at least three safety measures employed during the operation of a farm machine.

Assessment Level 3: Demonstrate how PPE should be put on correctly before commencing a pesticide spraying exercise.

Assessment Level 4

1. Discuss the importance of observing safety measures in operating farm machines.
2. Simulate how safety measures are employed in operating a given farm machine in agricultural production

Hint

The recommended mode of assessment for Week 4 is Group Project. Refer to Appendix D at the end of Section 1 for information on how to assign the project.

Week 5

Learning Indicator: Apply the knowledge and skills of safety measures in handling accidents and injuries of an agricultural worker using appropriate first aid

Focal Area: First aid in agricultural production

1. **Meaning of first aid and the contents of the first aid box**

   a. **Meaning of first aid**

   First aid refers to the initial assistance or treatment given to a person injured or suddenly taken ill before professional medical help can be obtained. It is the immediate care provided to preserve life, prevent the condition from worsening and promote recovery. First aid can involve a range of techniques and procedures, such as CPR (cardio-pulmonary resuscitation), bandaging cuts and wounds to reduce loss of blood, applying ointment to treat burns, managing fractures, administering medications for severe allergic reactions (anaphylaxis). It is crucial for anyone, regardless of their profession, to have at least basic knowledge of first aid to be able to respond effectively in emergencies and save lives.

   i. Key aspects of first aid

   - **Recognition:** Quickly identifying the nature and severity of the injury or illness.
   - **Intervention:** Providing appropriate care based on training and knowledge to stabilise the person's condition.
   - **Assessment:** Monitoring the person's vital signs and responding to any changes.
   - **Transportation:** Arranging for further medical assistance and transportation to a healthcare facility if needed.
   - **Support:** Offering reassurance and emotional support to the person and those around them.

2. **Some contents of first aid box and their uses**

   a. Adhesive bandages: These are used to cover small cuts, scrapes, or minor wounds. They help protect the wound from dirt and bacteria and promote healing.

   b. 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.

   c. Adhesive tape: Adhesive tapes secure dressings or bandages in place. They provide support and help keep the dressing clean and intact.

   d. 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.

   e. Disposable gloves: Gloves are essential for personal protection when providing first aid. They help prevent the spread of germs, protect the caregiver and maintain a sterile environment.

f. **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.

g. **Tweezers:** Tweezers are used to remove small splinters, foreign objects, or debris from wounds. They provide a precise grip and help maintain cleanliness.

h. **CPR mask or face shield:** These devices are used when performing cardio-pulmonary resuscitation to provide a barrier between the rescuer and the victim. They prevent the transmission of infections and infectious diseases.

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

j. **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.

k. **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.

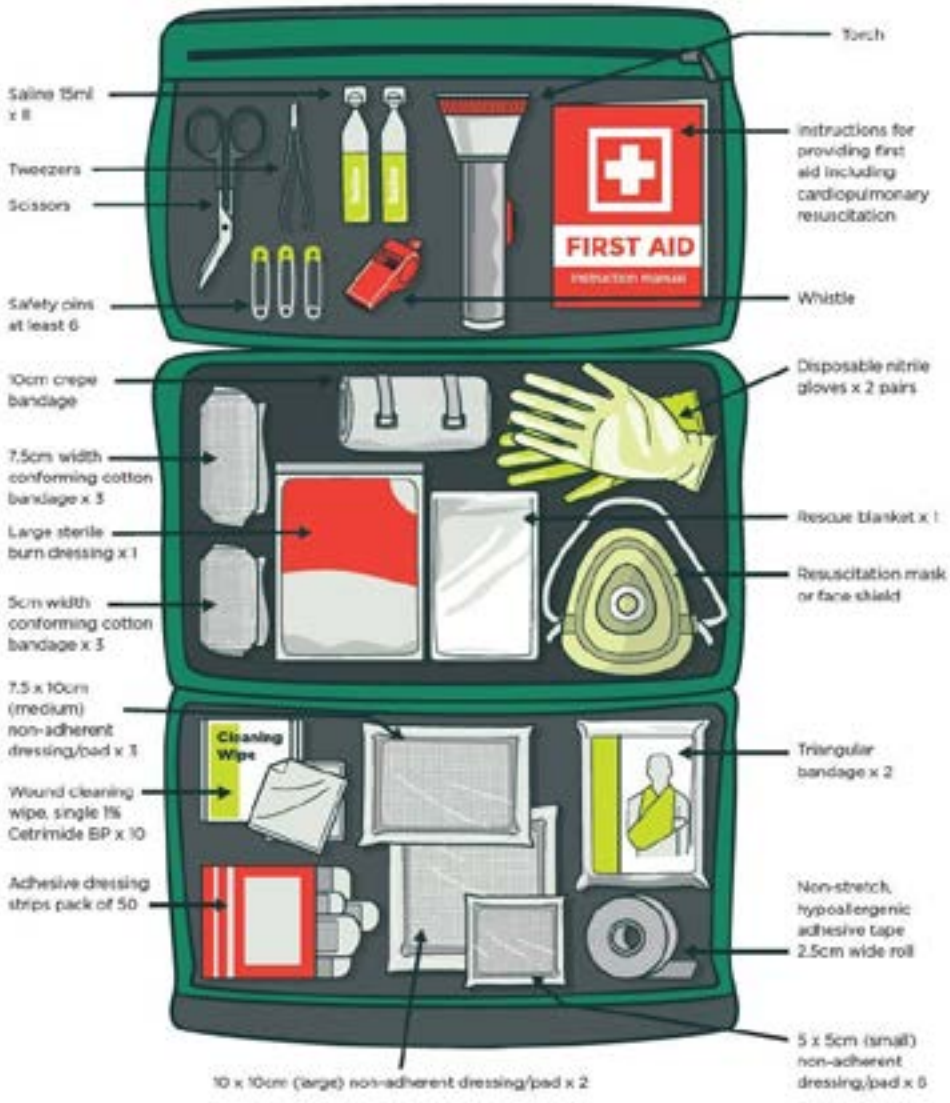

Figure 5.1: *Some items found in first aid box*

3. **Procedure for applying first aid**

First aid is to stabilise an injured worker while waiting for medical professionals to arrive. The specific first aid procedures will depend on the nature of the injury, but below are some of the common steps

a. Ensure the injured person has an open airway (trachea) and is breathing.

b. Control bleeding by applying direct pressure to the wound with a clean cloth or bandage.

c. Immobilise any suspected fractures or spinal injuries by keeping the injured person still with appropriate immobilisation techniques.

d. Assess the situation to ensure safety and identify potential hazards to prevent further harm to the first aid provider and others involved.

e. 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.

f. CPR administration: Administer CPR (cardiopulmonary resuscitation) if necessary and if trained.

g. 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.

h. 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.

4. **Implications of using inappropriate first aid materials and treatments**

   a. Prolonged pain and discomfort: Using inappropriate materials or chemicals can cause unnecessary pain and discomfort to the victim.

   b. Increased risk of infection: Using non-sterile materials or applying chemicals not intended for the purpose can increase the risk of infection.

   c. Delayed or inadequate wound healing: 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.

   d. Allergic reactions: Some individuals may have allergies or sensitivities to certain materials or chemicals e.g. 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.

   e. Tissue damage and scarring: Improper application of chemicals on wounds, especially caustic or corrosive chemicals, can lead to tissue damage and subsequent scarring.

5. **Indigenous ways of providing first aid to injured persons at a farm site**

   a. **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 alleviate pain.

b. **Traditional bandaging techniques:** Some indigenous communities have their unique methods of bandaging wounds. This includes natural fibres, such as leaves or tree bark, to create bandages or splints to immobilise injured limbs.

c. **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.

d. **Spiritual and cultural beliefs:** Indigenous first aid practices often incorporate spiritual and cultural beliefs. Ceremonies, prayers, or rituals may be performed alongside physical treatments to provide emotional support, invoke healing, or seek guidance from ancestral spirits or deities.

e. **Traditional bone setting:** Some cultures have specialised individuals known as "bone healers" or "traditional bone setters" with unique knowledge and skills in setting fractures and dislocations.

Learning Tasks

1. Identify the contents of a first aid box and their importance.
2. Discuss the implications of using inappropriate first aid materials to treat wounds.
3. Demonstrate indigenous ways of first aid to injured persons on a farm.

Pedagogical Exemplars

1. **Managing talk for learning:** In groups, learners discuss the contents of a first aid box and their uses. The teacher assists learners with real objects or pictures to identify some contents of a first aid box and their uses. Learners should be guided with probing questions to list other contents not included in the first aid box provided. Learners should be given opportunities to identify which of the contents they are familiar with.
2. **Experiential learning:** Learners in mixed-ability groups demonstrate the appropriate use of some PPE in agricultural production, particularly during the use of pesticides. Learners with prior knowledge and experience should guide the others.
3. **Collaborative learning:** Learners role-play and demonstrate first aid practices. Shy learners should be encouraged to participate.
4. **Initiate talk for learning:** Guided by a health worker or a first aider, learners in mixed-ability/mixed-gender groups (where applicable) discuss the implications of using inappropriate first aid materials and treatment of wounds. The health worker should show pictures of complications developed from inappropriate first aid materials to assist learners in appreciating the effects of using inappropriate first aid materials. Learners should be allowed to share experiences of using inappropriate first aid materials and applications of chemicals on wounds.
5. **Manage talk for learning:** Learners discuss the indigenous ways of providing first aid to injured persons at a farm site in mixed-ability groups. The teacher should use leading questions to guide learners to mention indigenous ways of providing first aid to injured persons on a farm. Learners should be allowed to share experiences of assisting injured

persons using indigenous methods. Teacher should alert learners on the dangers of some of these indigenous first aids where appropriate.

Key Assessments

Assessment Level 1: List at least five items found in a first aid box.

Assessment level 2: What are the uses of the following in a first aid box: a. bandage b. gauze c. plaster d. string e. alcohol?

Assessment Level 3: Discuss at least three implications of using inappropriate first aid materials in treating wounds.

Assessment Level 4

1. Prepare a table showing five injuries that can occur at a farm with the corresponding first aid in each case.
2. Scenario

   A farmer is operating a harvester on uneven terrain. While navigating a steep incline, the machine suddenly stalls, causing the farmer to lose balance and fall off the machine. He sustains a deep cut on his leg from sharp debris on the ground, and his foot gets stuck near the machine's moving part. Fortunately, the machine is not running, but the farmer is in significant pain and is at risk of further injury if not promptly assisted. As an agricultural science learner, how will you apply the knowledge and skills of safety measures to handle his injuries handle?

Hint

- *The recommended mode of assessment for week 5 is case study. Use the level 4 question 2 as a sample question.*
- *Refer to Appendix E and Teacher Assessment Manual and Toolkit page 25 for additional information on how to use a case study.*

SECTION 1 REVIEW

Scientific experimental procedure is a series of steps used to investigate research questions and draw relevant conclusions that help understand and explain or answer the questions hitherto unresolved. Scientific experimentation for agricultural production helps to improve crop and livestock production and ensures better decision-making. The steps in scientific experimentation, which include identifying a research problem, designing an experiment, collecting and analysing data and drawing conclusions, have been treated in this Section. The Section also explained the use of some scientific tools in agriculture for better understanding of plant and animal growth and development. Accidents occur during agricultural production. This Section considered the key safety measures that reduce accidents in farm operations particularly the role of personal protective equipment (PPE), regular maintenance and safe handling of chemicals. First aid in agricultural production, is also covered. The learning tasks and pedagogies have been chosen to encourage learners' collaboration and critical thinking.

APPENDIX A: MARKING SCHEME FOR THE DISCUSSION AND HOMEWORK ASSESSMENT

1. **DISCUSSION TASK**

Outline of the scientific experiment chronologically

a. Research problem
b. Experimental design
c. Data collection and analysis
d. Result interpretation
e. Reporting

(1 mark for each step and extra 1 mark for brief and clear explanation of each step)

a. Research Problem

i. Formulate a question: Identify a specific research question or problem to be addressed. 0.5 mark
ii. Set objectives: Clearly define the goals of the experiment and what you aim to demonstrate or learn, etc. 0.5 mark

b. Experimental design

i. Divide a field into plots and randomly assign different treatments and no treatment (control). 0.5 mark
ii. Use multiple replicates for each treatment to ensure reliable data, etc. 0.5 mark

2. **HOMEWORK**

a. **Soil pH meter:** Measures acidity or alkalinity of soil.
b. **Weighing scales (balances):** Measures mass or weight of substances in agriculture such as harvested crops to determine yield, etc.

1 mark for each of the 10 measuring instruments stated and 1 mark for stating the right usage

Total – 20 marks

Appendix B: Sample Portfolio Assessment Task

Refer to the Teacher Assessment Manual and Toolkits pages 22-25 for guidelines on portfolio assessment.

Task

Collect all your work for the academic year, starting from the beginning of the first semester, and compile it into a portfolio to be submitted at the end of the year for assessment. Your portfolio should include assignments, reports of projects, quizzes, tests, Posters, and mid-term and end-of-semester papers. This portfolio will be assessed to evaluate your overall understanding and progress throughout the year.

Artefacts

Example of learners' works to be included in the Portfolio Assessment

a. Assignments
b. Reports of Projects
c. Quizzes and Tests
d. Posters and Weeds album,
e. Mid semester and end of semester papers, etc.

Organisation/Structure

As part of the structure of the portfolio assessment, make sure the following information has been provided

a. Cover Page which entails the learner's name, class, subject and period/date.
b. Table of Contents which has the list of items included with page numbers.
c. Brief description/background of items such as short description of the significance of sports certificates and awards, background information for each included artefact etc.

How To Administer

Sample mode of administration

a. Explain the purpose and components of the portfolio to the learners and provide examples and templates for each section.
b. Schedule periodic reviews (e.g., every 3-4 weeks) to ensure learners are keeping up with their portfolios and provide feedback and guidance during these checkpoints, etc.
c. Communicate the final deadline for portfolio submission to all students to ensure timely and complete submissions.
d. Ensure the portfolio includes all required elements: assignments, projects, quizzes, tests, reflective pieces, class participation records, and a final reflection, etc.

Rubrics/Marking Scheme

Sample Portfolio Assessment Marking scheme

Learner's works	Score
Assignments/Exercises	10 marks
Reports of Projects	10 marks
Quizzes and Tests	10 marks
Posters and weeds album	10 marks
Mid-semester and End of first semester examination Papers	10 marks
Total marks	50 marks

Feedback

Schedule periodic check-ins to discuss progress, set goals, and adjust strategies as may needed, etc.

APPENDIX C: RUBRICS FOR THE DEMONSTRATION ASSESSMENT TASK

Criteria	Excellent (4 marks)	Good (3 marks)	Satisfactory (2 marks)	Needs Improvement (1 marks)
Understanding of Measurement Tools	Demonstrates clear understanding of all 4 tools Measuring tape To measure the area of the land. Weighing scale To measure the weight of the harvested crop. Quadrat frame (1 m^2 or any other standard size): To sample a smaller area. Calculator: To calculate the yield.	Demonstrates clear understanding of any 3 tools Measuring tape To measure the area of the land. Weighing scale To measure the weight of the harvested crop. Quadrat frame (1 m^2 or any other standard size): To sample a smaller area. Calculator: To calculate the yield.	Demonstrates clear understanding of any 2 tools Measuring tape To measure the area of the land. Weighing scale To measure the weight of the harvested crop. Quadrat frame (1 m^2 or any other standard size): To sample a smaller area. Calculator: To calculate the yield.	Demonstrates clear understanding of any 1 tool Measuring tape To measure the area of the land. Weighing scale To measure the weight of the harvested crop. Quadrat frame (1 m^2 or any other standard size): To sample a smaller area. Calculator: To calculate the yield.
Measuring and Sampling Process	Accurately describes and performs all 4 steps i. measuring land area ii. random quadrat iii.sampling, and iv.weighing crops.	Accurately describes and performs any 3 steps i. measuring land area ii. random quadrat iii.sampling, and iv.weighing crops.	Accurately describes and performs any 2 steps i. measuring land area, ii. random quadrat iii.sampling, and iv.weighing crops.	Accurately describes and performs any 1 steps i. measuring land area, ii. random quadrat iii.sampling, and iv. weighing crops.

Accuracy of Calculations	Performs all 4 steps Correctly calculates average yield per quadrat and extrapolates to total land area with no errors. All conversions (e.g., m^2 to hectares) are accurate. Clear writing	Performs any 3 steps Correctly calculates average yield per quadrat and extrapolates to total land area with no errors. All conversions (e.g., m^2 to hectares) are accurate. Clear writing	Performs any 2 steps: Correctly calculates average yield per quadrat and extrapolates to total land area with no errors. All conversions (e.g., m^2 to hectares) are accurate. Clear writing	Performs any 1 step: Correctly calculates average yield per quadrat and extrapolates to total land area with no errors. All conversions (e.g., m^2 to hectares) are accurate. Clear writing
Observation and Record-Keeping	Detailed and organized recording of all 4 of the following measurements, weights, and calculations in a notebook. Records include observations of the process and trends.	Detailed and organized recording of any 3 of the following measurements, weights, and calculations in a notebook. Records include observations of the process and trends.	Detailed and organized recording of any 2 of the following measurements, weights, and calculations in a notebook. Records include observations of the process and trends.	Detailed and organized recording of any 1 of the following measurements, weights, and calculations in a notebook. Records include observations of the process and trends.
Communication of Results	All 4 of the following Results are; clearly communicated with a comprehensive explanation of methods, calculations, and findings. Data presentation is effective and logical.	Any 3 of the following Results are; clearly communicated with a comprehensive explanation of methods, calculations, and findings. Data presentation is effective and logical.	Any 2 of the following Results are: clearly communicated with a comprehensive explanation of methods, calculations, and findings. Data presentation is effective and logical.	Any 2 of the following Results are: clearly communicated with a comprehensive explanation of methods, calculations, and findings. Data presentation is effective and logical.

Total score: 20 marks

APPENDIX D: GROUP PROJECT

Safety and First Aid in Agricultural Production

Duration: 5 Weeks

Project Overview

In this project, you will work in groups to research, discuss, and demonstrate safety practices for operating farm machines and the importance of first aid in agricultural production. The project will build awareness of common farm hazards, promote safe practices, and prepare you to respond effectively to accidents or emergencies on the farm.

At the end of 5 weeks, each group will present a safety and first aid guidebook (written), a practical demonstration, and a poster or chart for class display.

Step-by-Step Approach

Week 1: Group Formation & Research

- Form groups of 4–6 learners.
- Assign roles: researcher, note-taker, presenter, illustrator, coordinator.
- Research common farm machines used in Ghana (tractors, harvesters, knapsack sprayers, etc.) and identify potential hazards.
- Begin a list of common accidents in agricultural production (cuts, burns, falls, chemical poisoning).

Week 2: Safety in Farm Machine Operation

- Research and record safety guidelines for operating at least two farm machines (e.g., tractor and knapsack sprayer).
- Create a safety checklist for operators (protective clothing, inspection before use, safe handling techniques).
- Discuss how ignoring safety rules could affect productivity and health.

Week 3: First Aid in Agricultural Production

- Research basic first aid procedures for common farm accidents:
  - Cuts and wounds
  - Burns
  - Snake/insect bites
  - Chemical poisoning
- Prepare a step-by-step first aid guide for at least 3 farm-related accidents.
- Collect or draw diagrams to illustrate first aid kits and procedures.

Week 4: Developing the Project Output

- Compile findings into a Safety and First Aid Guidebook for Farmers (5–6 pages).

- Design a poster/chart showing safety precautions and first aid steps.
- Rehearse a practical demonstration:
  - Demonstrating safe operation of a chosen machine (simulation if real machines unavailable).
  - Demonstrating first aid for one common accident (role-play).

Week 5: Presentation & Reflection

- Each group presents their Guidebook, Poster, and Demonstration.
- Class discussion and peer feedback.
- Groups submit a reflection note (½ page per member) on what they learned about farm safety and first aid.

Expected Outputs

1. Safety and First Aid Guidebook (group-written, 5–6 pages).
2. Poster/Chart for classroom display.
3. Practical Demonstration (role-play + checklist).
4. Reflection Notes from each group member.

Sample Rubric (20 Marks)

Criteria	Excellent (4)	Good (3)	Fair (2)	Needs Improvement (1)
Content Accuracy	Guidebook and poster contain accurate, detailed safety and first aid information.	Mostly accurate with minor errors.	Some inaccuracies or missing details.	Major errors; very limited content.
Application & Relevance	Strong real-life connections; shows clear understanding of farm practices.	Some good connections; generally clear.	Limited application to real farm life.	No real-life application.
Teamwork & Organisation	Excellent cooperation; roles clearly defined; outputs well-structured.	Good teamwork; minor issues in structure.	Some teamwork but uneven contribution.	Poor teamwork; disorganised output.
Creativity & Presentation	Poster and demo are engaging, clear, and well-illustrated.	Clear but less engaging presentation.	Some effort in creativity, limited clarity.	Minimal creativity or unclear.
Reflection	Insightful reflections showing personal growth.	Some reflections with relevant points.	Reflections vague or minimal.	No reflections submitted.

APPENDIX E: RUBRICS FOR THE CASE STUDY ASSESSMENT TASK

Key aspects of appropriate first aid

i. Recognition
ii. Intervention
iii. Assessment
iv. Transportation
v. Support

(1 mark for identifying each of key procedure and 3 marks for correctly demonstrating each practically)

Criteria	Excellent (4 marks)	Good (3 marks)	Satisfactory (2 marks)	Needs Improvement (1 mark)
1. Emergency Shutdown & Machine Safety	i. Immediately powers down the machine using the emergency shutdown mechanism to stop all moving parts. ii. Engages safety locks or brakes to ensure the machine remains stationary. iii. Uses tools (e.g., crowbar or wrench) to safely free the farmer's foot without causing further injury. iv. Ensures the area around the machine is secured to prevent additional accidents (e.g., clearing debris, turning off power).	i. Immediately powers down the machine using the emergency shutdown mechanism to stop all moving parts. ii. Engages safety locks or brakes to ensure the machine remains stationary. iii. Uses tools (e.g., crowbar or wrench) to safely free the farmer's foot without causing further injury. iv. Ensures the area around the machine is secured to prevent additional accidents (e.g., clearing debris, turning off power).	i. Immediately powers down the machine using the emergency shutdown mechanism to stop all moving parts. ii. Engages safety locks or brakes to ensure the machine remains stationary. iii. Uses tools (e.g., crowbar or wrench) to safely free the farmer's foot without causing further injury. iv. Ensures the area around the machine is secured to prevent additional accidents (e.g., clearing debris, turning off power).	i. Immediately powers down the machine using the emergency shutdown mechanism to stop all moving parts. ii. Engages safety locks or brakes to ensure the machine remains stationary. iii. Uses tools (e.g., crowbar or wrench) to safely free the farmer's foot without causing further injury. iv. Ensures the area around the machine is secured to prevent additional accidents (e.g., clearing debris, turning off power). Any 1 point for 1 mark

	All 4 points for 4 marks	Any 3 points for 3 marks	Any 2 points for 2 marks	
2. First Aid Application	i. Cleans the wound thoroughly with antiseptic solution to prevent infection. ii. Applies firm, sterile dressing to control bleeding effectively. iii. Elevates the injured limb (if possible) to minimize swelling and blood loss. iv. Explains the importance of each first aid step to bystanders to ensure clarity and calm. All 4 points for 4 marks	i. Cleans the wound thoroughly with antiseptic solution to prevent infection. ii. Applies firm, sterile dressing to control bleeding effectively. iii. Elevates the injured limb (if possible) to minimize swelling and blood loss. iv. Explains the importance of each first aid step to bystanders to ensure clarity and calm. Any 3 points for 3 marks	i. Cleans the wound thoroughly with antiseptic solution to prevent infection. ii. Applies firm, sterile dressing to control bleeding effectively. iii. Elevates the injured limb (if possible) to minimize swelling and blood loss. iv. Explains the importance of each first aid step to bystanders to ensure clarity and calm. Any 2 points for 2 marks	i. Cleans the wound thoroughly with antiseptic solution to prevent infection. ii. Applies firm, sterile dressing to control bleeding effectively. iii. Elevates the injured limb (if possible) to minimize swelling and blood loss. iv. Explains the importance of each first aid step to bystanders to ensure clarity and calm. Any 1 point for 1 mark
3. Communication & Farmer Assessment	i. Assesses the injured farmer's level of pain and range of motion to gauge severity. ii. Clearly explains every action being taken to reassure the farmer. iii. Asks critical questions (e.g., "Do you feel pain anywhere else?") to identify	i. Assesses the injured farmer's level of pain and range of motion to gauge severity. ii. Clearly explains every action being taken to reassure the farmer. iii. Asks critical questions (e.g., "Do you feel pain anywhere else?") to identify	i. Assesses the injured farmer's level of pain and range of motion to gauge severity. ii. Clearly explains every action being taken to reassure the farmer. iii. Asks critical questions (e.g., "Do you feel pain anywhere else?")	i. Assesses the injured farmer's level of pain and range of motion to gauge severity. ii. Clearly explains every action being taken to reassure the farmer. iii. Asks critical questions (e.g., "Do you feel pain anywhere else?") to identify additional injuries. iv. Records vital details (time,

	additional injuries. iv. Records vital details (time, symptoms, actions taken) for medical professionals. All 4 points for 4 marks	additional injuries. iv. Records vital details (time, symptoms, actions taken) for medical professionals. Any 3 points for 3 marks	to identify additional injuries. iv. Records vital details (time, symptoms, actions taken) for medical professionals. Any 2 points for 2 marks	iv. symptoms, actions taken) for medical professionals. Any 1 point for 1 mark
4. Emergency Assistance Call	i. Uses a clear, calm voice to communicate with emergency services. ii. Provides precise location details, including landmarks and coordinates if available. iii. Describes the farmer's condition and nature of the accident succinctly. iv. Stays on the call to follow instructions and answer any additional questions from emergency responders. All 4 points for 4 marks	i. Uses a clear, calm voice to communicate with emergency services. ii. Provides precise location details, including landmarks and coordinates if available. iii. Describes the farmer's condition and nature of the accident succinctly. iv. Stays on the call to follow instructions and answer any additional questions from emergency responders. Any 3 points for 3 marks	i. Uses a clear, calm voice to communicate with emergency services. ii. Provides precise location details, including landmarks and coordinates if available. iii. Describes the farmer's condition and nature of the accident succinctly. iv. Stays on the call to follow instructions and answer any additional questions from emergency responders. Any 2 points for 2 marks	i. Uses a clear, calm voice to communicate with emergency services. ii. Provides precise location details, including landmarks and coordinates if available. iii. Describes the farmer's condition and nature of the accident succinctly. iv. Stays on the call to follow instructions and answer any additional questions from emergency responders. Any 1 point for 1 mark

5. Safe Transportation	i. Employs correct lifting or moving techniques (e.g., two-person carry or stretcher use) to avoid aggravating the injury. ii. Ensures the injured limb is stabilized during movement. iii. Uses a makeshift stretcher, if necessary, made from nearby materials to ensure support. iv. Avoids unnecessary jarring or twisting movements while transporting the farmer. All 4 points for 4 marks	i. Employs correct lifting or moving techniques (e.g., two-person carry or stretcher use) to avoid aggravating the injury. ii. Ensures the injured limb is stabilized during movement. iii. Uses a makeshift stretcher, if necessary, made from nearby materials to ensure support. iv. Avoids unnecessary jarring or twisting movements while transporting the farmer. Any 3 points for 3 marks	i. Employs correct lifting or moving techniques (e.g., two-person carry or stretcher use) to avoid aggravating the injury. ii. Ensures the injured limb is stabilized during movement. iii. Uses a makeshift stretcher, if necessary, made from nearby materials to ensure support. iv. Avoids unnecessary jarring or twisting movements while transporting the farmer. Any 2 points for 2 marks	i. Employs correct lifting or moving techniques (e.g., two-person carry or stretcher use) to avoid aggravating the injury. ii. Ensures the injured limb is stabilized during movement. iii. Uses a makeshift stretcher, if necessary, made from nearby materials to ensure support. iv. Avoids unnecessary jarring or twisting movements while transporting the farmer. Any 1 point for 1mark
6. Hazard Prevention & Risk Discussion	i. Analyses the root cause of the accident, such as slippery terrain or improper footwear. ii. Suggests preventative measures like mandatory use of safety boots and anti-slip mats.	i. Analyses the root cause of the accident, such as slippery terrain or improper footwear. ii. Suggests preventative measures like mandatory use of safety boots and anti-slip mats.	i. Analyses the root cause of the accident, such as slippery terrain or improper footwear. ii. Suggests preventative measures like mandatory use of safety boots and anti-slip mats.	i. Analyses the root cause of the accident, such as slippery terrain or improper footwear. ii. Suggests preventative measures like mandatory use of safety boots and anti-slip mats. iii. Recommends regular machine maintenance to ensure safety

	iii. Recommends regular machine maintenance to ensure safety features are functioning. iv. Advises on the importance of training for all machine operators, including emergency response drills. All 4 points for 4 marks	iii. Recommends regular machine maintenance to ensure safety features are functioning. iv. Advises on the importance of training for all machine operators, including emergency response drills. Any 3 points for 3 marks	iii. Recommends regular machine maintenance to ensure safety features are functioning. iv. Advises on the importance of training for all machine operators, including emergency response drills. Any 2 points for 2 marks	features are functioning. iv. Advises on the importance of training for all machine operators, including emergency response drills. Any 1 point for 1 mark

SECTION 2: ARABLE CROP PRODUCTION

Strand: New Dawn in Agriculture

Sub-Strand: Misconceptions and Prospects in Agriculture and Farming

Learning Outcome: Analyse patterns in the startup and growth of successful arable crop enterprises (cereals, legumes, and tuber crops)

Content Standard: *Demonstrate knowledge and understanding of factors and processes that influence successful arable crop enterprises (cereals, legumes, and tuber crops)*

Hint

Remind learners of Mid-Semester examination in week 6. Refer to the Appendix G for more sample task and the Table of Specification.

INTRODUCTION AND SECTION SUMMARY

Arable crop production is a cornerstone of the agricultural sector in Ghana and an essential part of our curriculum at the Senior High School level. This section delves into the dynamics of arable crop farming, where learners will understand the principles and practices that underpin the cultivation of arable crops, including cereals, legumes and tubers. Learners 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. Additionally, learners will explore 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.

The weeks covered by the section are:

Week 6*:* Introduction to arable crop production

Week 7:

a. Startup packages of arable crop enterprises

b. Patterns of growth of successful arable crop enterprises

SUMMARY OF PEDAGOGICAL EXEMPLARS

Effective pedagogical strategies create a more engaging, inclusive and productive learning environment, leading to better learning outcomes. This section employs pedagogy that involves technology i.e. combining traditional and digital approaches to provide a more flexible and effective learning experience. Collaborative, digital, enquiry-based and activity-based learning will help learners grasp the importance of arable crops in the agricultural landscape and the economy of the nation. Through hands-on activities and field visits, learners will experience

the science of arable crop production. For start-up packages, characteristics and patterns of growth of arable crop enterprises, exploratory, experiential, structured talk for learning pedagogies should be deployed to enable learners to gain a deeper knowledge and skills in the field of arable crop production. Teachers are encouraged to consider the diverse needs of the learners and tailor their pedagogical strategies to meet their needs.

ASSESSMENT SUMMARY

The section emphasises assessment strategies that align with the learning indicators and content standards, ensuring that assessments accurately measure the intended learning outcomes of the curriculum. The assessment tools to be deployed by teachers include individual responses to oral questions on the meaning, examples and importance of arable crop production. Group presentations in the plenary on start-up packages, characteristics and patterns of growth of arable crop enterprises, will allow learners to communicate their ideas and findings hence improving their communication skills and critical thinking. Written responses to questions or tasks in mixed-gender or mixed-ability groups, where appropriate, will help learners develop orderly presentation of ideas and also enhance their writing skills. The transcript system should be updated with learners' performance in oral presentations, written exercises, tests and project work.

Week 6

Learning Indicator: Describe the economic importance of selected arable crops (cereals, legumes, and tubers) in the livelihood of the producers and the broader value chain

Focal Area 1: Introduction to arable crop production

Meaning and Examples of Arable Crops

Arable crops grow best in well-drained soils and are typically used for human consumption or animal feed. They are usually annuals replanted yearly and are often rotated to maintain soil fertility and control pests and diseases. These crops require nutrient-rich soils amenable to ploughing and harvesting machinery and a favourable climate to grow. Examples of arable crops include:

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

Examples of Cereals

Maize

Rice

Millet

Sorghum

Wheat

Figure 6.1: *Cereals*

Examples of Legumes

Cowpea

Groundnut

Soya beans

Bambara groundnut

Lima beans

Figure 6.2: *Legumes*

Examples of Roots and Tubers

Sweet potato

Taro

Cocoyam

Irish potato

Cassava

Yam

Figure 6.3: *Roots and Tubers*

Factors and Processes that Influence Successful Arable Crop Production

1. **Soil quality:** Soils with adequate nutrients, good structure, favourable pH (pH 6-7) and good organic matter content are required for successful arable crop production.
2. **Climate and weather conditions:** Climate and weather conditions play important roles in arable crop growth and development. The intensity and duration of the weather factors are crucial for the various physiological processes they affect.
3. **Water management:** It is essential to consider efficient irrigation systems such as drip or sprinkler irrigation to ensure crops receive the right amount of water. Proper drainage prevents waterlogging and root diseases for successful arable crop production.
4. **Seed quality:** High-quality seeds that are free from debris, diseases and pathogens, with high germination rates are also needed. Crop varieties suited to local conditions and resistant to pests and diseases are required for successful arable crop enterprises.
5. **Crop management practices:** To be successful in arable crop production, farmers should consider the following

    a. Proper planting depth and spacing to optimise growth.

    b. Timely and effective weed control to prevent competition for nutrients, water and sunlight.

    c. Monitoring and integrated pest management (IPM) strategies to control pests and diseases.

4. **Nutrient management:** Adequate and timely application of fertilisers, based on soil testing, should be considered to ensure successful arable crop production. To ensure sustainable farming, farmers should consider using compost, farmyard manure, and green manures to improve soil health.
5. **Technology and mechanisation:** Modern machinery for land preparation, planting, weeding and harvesting are essential for increasing efficiency in arable crop production. Technologies like GPS and drones help in the precise application of inputs, and monitoring crop health.
6. **Economic factors:** Input availability and affordability are as important as markets to sell the produce at a profitable price.
7. **Sustainable practices:** Farmers should employ sustainable agricultural practices such as crop rotation, cover cropping, and conservation tillage to maintain soil structure and reduce erosion.
8. **Proper post-harvest handling:** To obtain the maximum benefits from arable crop enterprises, post-harvest handling such as cleaning, grading, packaging of produce and proper storage facilities to prevent spoilage and maintain quality are crucial.

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. An outline is as follows:

1. **Livelihood of producers**

a. Employment creation: The cultivation, harvesting, processing and transportation of arable crops generate substantial employment opportunities in rural areas.

b. Income generation: Arable crops provide a primary source of income for many farmers. Cash crops like maize, soya beans and yam are sold in local and international markets, providing farmers with crucial financial resources.

c. Food security and nutrition: Many arable crops such as rice, maize, cassava etc. are staple foods that ensure the food security of farming households in Ghana.

d. Market diversification: Farmers can grow many crops to reduce dependency on a single crop and allow them to spread risk and stabilise income.

e. Economic independence of smallholder farmers: Access to markets and fair crop prices significantly empower small-holder farmers improving their socio-economic status.

2. **National economy**

a. Agricultural employment: A significant portion of the population is employed 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: Arable crops provide raw materials for industries such as food processing, textiles and biofuels to ensure the sustainability of these industries.

d. Industrial growth: The processing of crops into various products supports the viability of agri-processing industries and creates additional jobs in sectors such as milling, oil extraction, and food packaging.

e. Foreign exchange: Ghana earns significant foreign exchange from the export of arable crops.

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.

Learning Tasks

1. Learners to define and give examples of arable crops.
2. Learners to outline factors that influence successful arable crop production.
3. Learners to discuss the economic importance of selected arable crops in the livelihood of the producers and the nation.

Pedagogical Exemplars

1. **Collaborative digital learning:** Learners in groups, surf the Internet to find the meaning and examples of arable crops and factors that influence their successful production and make presentations to the class. Learners more competent at browsing the Internet should be encouraged to help their peers who are less confident.
2. **Enquiry-based learning:** Learners in mixed-ability groups visit vendors of selected arable crops (cereals, legumes and tubers) to map the movement of such commodities from producers to consumers and ask the vendors about the economic benefits of producing and or trading the commodities on the livelihoods of producers and the nation. The teacher should guide learners with probing questions to enable them to get the necessary data needed.
3. **Activity-based learning:** In groups, learners write reports on the effect of producing and or trading in the commodities on the livelihoods of producers and the nation based on the data gathered from the visit. More competent learners should be encouraged to lead and assist their peers in writing the report.

Key Assessments

Assessment Level 1: What is an arable crop? List the names of five arable crops in Ghana.

Assessment Level 2: Give five examples of the economic importance of arable crop production in Ghana.

Assessment Level 3: Discuss four factors that influence arable crop production.

Hint

*The recommended mode of assessment for week 6 is **Mid-semester examination.** Refer to the Appendix G for more sample task and the Table of Specification*

Week 7

Learning Indicators

1. *Discuss characteristics of successful startup packages of arable crop enterprises*
2. *Catalogue the characteristics and patterns of growth of successful arable crop (cereals, legumes, and tuber crops) enterprise*

Focal Area 1: Startup Packages of Arable Crop Enterprises

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

1. **Initial capital:** Securing financing through loans, grants, family investment or investors.
2. **Land acquisition and preparation**
    a. **Land purchase or lease:** Initial investment for purchasing or leasing land suitable for arable crop cultivation.
    b. **Soil testing:** Soil is tested to determine soil fertility and the need for amendments.
    c. **Land clearing and preparation:** This includes ploughing, levelling and possibly drainage systems.
3. **Seeds and planting materials**
    a. **Certified seeds:** High-quality seeds of the chosen arable crop variety.
    b. **Nursery establishment:** For crops that require seedlings before 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:** For regular education and update of workers on best practices.
7. **Fertilisers and soil amendment materials**
    a. **Organic and inorganic fertilisers:** To 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.
b. **Drying equipment:** To reduce moisture content and pest load before storage.

11. **Transportation**

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.
b. **Environmental impact assessments:** Required by law.

Example of a start-up package for a small-scale maize farming enterprise

	ITEM	COST (GH₵)
1.	**Land acquisition and preparation**	
	Lease 10 hectares of arable land per year	1,000.00
	Soil testing and amendments	500.00
	Land clearing and preparation	2,000.00
2.	**Seeds and planting materials**	
	Certified maize seeds	500.00
3.	**Fertilisers and pest control**	
	Fertilisers	2,000.00
	Pesticides and herbicides	500.00
4.	**Irrigation and equipment**	
	Drip irrigation system	3,000.00
	Tractor lease per year	2,000.00
	Basic hand tools	1,000.00
5.	**Labour**	

	Labour for planting / harvesting	3,000.00
6.	**Storage and transport**	
	Temporary storage facility	1,000.00
	Transportation costs	2,500.00
7.	**Administrative costs**	
	Initial capital and contingency fund	5,000.00
	Insurance and legal fees	5,000.00
	Total Estimated initial investment	29,000.00

NB: These 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.

Learning Tasks

1. Learners to prepare a questionnaire to use as they visit farms. Questions could include:
   a. What are the requirements needed to start an arable crop enterprise?
   b. How did you start the farm?
   c. What factors did you consider when establishing the farm?
   d. How were you able to fund your project?
2. Learners administer the questionnaire on start-up packages for arable crop enterprises.
3. Learners analyse their findings and determine how the responses will help them to start a farm.
4. Learners to assess the requirement for starting an arable crop and prepare a budget for a start-up package.

Pedagogical Exemplars

1. **Exploratory learning:** Teacher and learners embark on educational visits to successful arable crop farms for learners to observe, ask questions and take field notes on start-up packages using a prepared questionnaire. Alternatively, resource persons can be invited to the school for the same purpose. All learners should be encouraged to participate fully.
2. **Structured talk for learning:** Learners discuss their observations from the educational visit in class in mixed ability groups to determine their readiness to start a garden. The teacher should consider shy and introverted learners and encourage their participation.
3. **Problem-solving:** Learners, prepare a budget with the help of teachers, for start-up packages for different arable crops to be sent to NGOs or any other source for assistance.

Key Assessments

Assessment Level 1: List the main components of the start-up package for an arable crop farm.

Assessment Level 2: Describe four components of a start-up package for an arable crop farm.

Assessment Level 3: Analyse factors that account for success and challenges in starting arable crop enterprises.

Assessment Level 4: Prepare budgets for start-up packages for any two arable crops to be sent to an NGO for assistance.

Focal Area 2: 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. Successful arable crop enterprises exhibit certain characteristics and growth patterns toward their sustainability and profitability. Below is a comprehensive catalogue of these features

1. **Characteristics of successful arable crop enterprises**

    a. **Crop selection and diversification:** Successful arable crop enterprises select crops well-suited to the local climate, soil, and market conditions. They grow and rotate many crop varieties to spread risk and increase resilience against pests, diseases, and market fluctuations.

    b. **Technology adoption:** Precision agriculture involves GPS, drones, and data analytics to optimize planting, irrigation and harvesting. Farmers also invest in modern machinery for planting, spraying, and harvesting to increase productivity. Biotechnological methods like genetically modified crops with enhanced resistance to pests and diseases for larger yields are also adopted.

    c. **Efficient resource management:** Regular soil testing, use of organic matter and crop rotation to maintain soil fertility are key features of these enterprises. Efficient irrigation systems, water conservation practices, and drought-tolerant crop varieties are also used.

    d. **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.

    e. **Market analysis:** Successful farmers understand the market demand and grow crops with high market demand and favourable price trends. To add value and increase profitability, crop produce is processed and packaged.

    f. **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.

2. **Patterns of growth in successful arable crop enterprises**

   a. **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.

   b. **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.

   c. **Collaboration:** Partnerships with other farmers, agribusinesses, research institutions and government agencies to enhance growth.

   d. **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.

Learning Tasks

1. Learners to identify and list characteristics of successful arable crop enterprises
2. Learners to discuss factors that affect the growth patterns of arable crop enterprises.

Pedagogical Exemplars

1. **Collaborative learning:** Learners in mixed ability groups, brainstorm the characteristics of successful arable crop enterprises and discuss them among the group members. The teacher should guide learners with leading questions and encourage all learners to participate. Learners share with other members of the class.
2. **Experiential learning:** Teacher should lead learners to visit successful arable crop (cereals, legumes, and tuber crops) enterprises in their communities to observe, ask questions, take field notes on patterns of growth and present reports. Should this be impossible, resource persons can be engaged to visit the school.

Key Assessments

Assessment Level 1: List four characteristics of successful arable crop enterprises.

Assessment Level 2: Explain three factors that affect the growth patterns of arable crop enterprises.

Assessment Level 3

1. Explain the relevance of studying factors that affect the growth pattern of arable enterprises.
2. Identify and explain five (5) characteristics of successful start-up packages for arable crop enterprises

Hint

*The recommended mode of assessment for week 7 is **class exercise**. Use the level 3 question 2 as a sample question.*

SECTION 2 REVIEW

The common arable crops grown in Ghana include cereals (maize, rice, millet, sorghum), legumes (cowpea, groundnut, soya bean and Bambara groundnut) and root and tubers (cassava, yam, sweet potato, cocoyam). To start arable crop farming, factors such as soil quality, climate and weather conditions, water management, seed quality and crop management practices, technology adoption and mechanisation are considered. The economic importance of the production of arable crops in the livelihood of producers and the nation was adequately covered. Details of startup packages for arable crop enterprises including land acquisition, planting materials and input acquisition, farm machinery and tools, labour, administrative setup and markets, are outlined. Characteristics of successful arable crop enterprises including crop diversification, efficient resource management, adoption of technology, financial planning and management have been covered. Successful arable crop enterprises adopt growth patterns such as incremental expansion, innovation, sustainability and resilience plans to ensure growth.

APPENDIX F: MARKING SCHEME FOR THE CLASS EXERCISE ASSESSMENT TASK

Identification of setup characteristics

Initial capital

Land acquisition and preparation

Land clearing and preparation

Seeds and planting materials

Pest and disease control chemicals, equipment and technologies etc.

Explanations

a. Initial capital: Financing through loans, grants, friends, family investment or investors.

b. Land acquisition and preparation

   i. Land purchase or lease

   ii. Soil testing, etc

c. Land clearing and preparation: Ploughing, levelling and possibly drainage system, etc.

d. Seeds and planting materials

   i. Certified seeds

   ii. Nursery establishment, etc.

e. Farm machinery and tools

   i. Tractors and implements: Ploughing, planting, cultivating, harvesting, etc.

   ii. Hand tools: Such as hoes, machetes, and spades for weeding, slashing, etc.

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

(2 marks for each of the 5 characteristics identified and well explained)

APPENDIX G: TABLE OF SPECIFICATION FOR MID-SEMESTER EXAMS, FIRST SEMESTER

Hint

Cover content from weeks 1-5. Taking into consideration DoK levels 1-4.

Weeks	Learning indicators(s)	Type of Questions	DoK Levels				Total
			1	2	3	4	
1	The meaning and relevance of scientific experimental procedure in Agricultural Science. 2. Scientific experimental procedures in Agricultural Science	Multiple Choice	1	1	-	-	2
2	Measuring instruments used in agricultural production	Multiple Choice	1	1	1	-	3
		Test of Practical			1		1
3	Simple scientific measuring tools for assessing parameters in agricultural production.	Multiple Choice	1	-	1	-	2
		Essay		1			1
4	Safety in operating farm machines in agricultural production.	Multiple Choice		1	-	-	1
5	First aid in agricultural production.	Multiple Choice	1	1			2
		Essay			1		1
	Total		4	5	4	0	13
			30%	40%	30%		100%

SECTION 3: EMERGING TECHNOLOGIES IN ARABLE CROP PRODUCTION

Strand: New Dawn Agriculture

Sub-Strand: Emerging Technologies in Agriculture

Learning Outcome: Appraise and use emerging technologies in arable crop (cereals, legumes, and tuber crops) enterprises

Content Standard: *Demonstrate knowledge and understanding of emerging technologies and their benefits in arable crop enterprises (cereals, legumes, and tuber crops) and relate it to what is in the community.*

Hint

Assign learners group project on the production of yam using mini-sett technique in week 9 to be submitted in week 11. Refer to Appendix I at the end of this section for more information on the project.

INTRODUCTION AND SECTION SUMMARY

In the evolving landscape of agricultural education, it is imperative to equip senior high school students with the knowledge and skills required to thrive in modern farming practices. Two pivotal areas of focus are precision agriculture in arable crop enterprises and the mini-sett technique in yam production. This section is to help learners gain detailed knowledge about the meaning, specific applications of precision agriculture in arable crop production and challenges involved in using precision agriculture to improve arable crop production. Learners are also expected to have in-depth knowledge and skills in the application of mini-sett technique in yam production. This includes the steps involved in obtaining the mini-setts, how to pre-sprout and transplant them and the benefits of using mini-setts in yam production as compared to the traditional way of producing ware yam.

The weeks covered by the section are:

Week 8: Explain the role of precision agriculture in arable crop enterprises.

Week 9: Describe the use and importance of mini-sett technique in seed yam production.

SUMMARY OF PEDAGOGICAL EXEMPLARS

Incorporating effective pedagogical strategies into the Senior High School curriculum is crucial for teaching innovative agricultural techniques such as precision agriculture in arable crop enterprises and the mini-sett technique in yam production. These strategies aim to bridge the gap between theoretical knowledge and practical application, ensuring that learners gain a

comprehensive understanding of modern agricultural practices. Strategies such as collaborative digital learning should be used to teach the meaning and components of precision agriculture, structured talk for learning to teach the meaning and objectives, benefits and challenges of precision agriculture, experiential learning to help learners practice mini-sett techniques and to demonstrate precision agriculture using variable rate seeding, while activity-based learning is necessary to understand the benefits of mini-sett techniques in yam production. Teachers should consider the diverse cultural background and learning abilities of learners when deploying these pedagogical strategies to meet their needs.

ASSESSMENT SUMMARY

Effective assessment for learning strategies help learners to grasp theoretical concepts and develop practical competencies. These strategies should encompass a blend of formative and summative assessments, hands-on activities, project-based learning and the integration of technology to ensure understanding of innovative agricultural techniques. Teachers should assign projects that require learners to design a precision agriculture plan or a yam mini-sett propagation project to allow them to apply theoretical knowledge in practical scenarios. Teachers should give exercises and tests on key concepts of precision agriculture and the mini-sett technique to help gauge learners' understanding and retention of knowledge. Continuous observation should also be used to assess learners during practical sessions with immediate feedback to help identify areas where they need improvement. Differences in the learners' abilities and competences should be considered when designing the assessment tools.

Week 8

Learning Indicator: Explain the role of precision agriculture in arable crop enterprises

Focal Area: Precision agriculture in arable crop enterprises

MEANING AND IMPORTANCE OF PRECISION AGRICULTURE IN ARABLE CROP ENTERPRISES

Meaning of Precision Agriculture

Precision agriculture, also known as precision farming, refers to 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 involves collecting and analysing data on soil type, crop health, weather conditions and other factors to make informed decisions about planting, irrigation, fertiliser application and harvesting. The goal of precision agriculture is to optimise crop yields by providing only the needed quantities 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) allow farmers to map and analyse soil, crop and farm locations and conditions precisely.
2. **Drones:** Capture high-resolution aerial imagery 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. VRT is informed by the imagery and information provided by drones.
4. **Soil sensors:** These sensors monitor soil type, moisture content, pH, and nutrient content to inform irrigation and fertiliser applications.
5. **Automated irrigation systems:** Such systems switch on and off automatically according to the soil moisture content and water needs of the crop. The automation is based on sensors and weather forecasts. Hence water is supplied to the crop only when needed and in the correct amount.
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 various sources to create predictive models and inform decision-making.

Figure.8.1: *Spot spraying drones Figure.8.2: 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, ensuring optimal plant population density for different field zones.
2. **Water conservation:** Precision irrigation systems reduce water wastage by applying the right amount of water to the right areas at the right time.
3. **Reduced chemical use:** Precision agriculture minimises the use of herbicides, pesticides and fertilisers by applying the required quantities, and only where needed, reducing any negative environmental impact and cost.
4. **Improved decision-making:** The data-driven approach of precision agriculture enables farmers to make more informed decisions based on enhanced understanding of field variability and its impact on crop performance.
5. **Increased efficiency:** Precision agriculture automates many farming processes, reducing labour costs and improving productivity.
6. **Real-time monitoring:** Precision agriculture enables farmers to monitor their crops in real-time, allowing for swift action to be taken in response to any issues that may arise.
7. **Minimizing 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 ensures yield increases by enabling farmers to manage their fields more accurately. Technologies like yield monitors and remote sensing provide detailed information on field variability, allowing for better crop management decisions.
9. **Environmental sustainability:** Precision agriculture promotes sustainable farming practices, reducing the environmental impact of arable crop production.

Challenges of precision agriculture in arable crop enterprises

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 for small and medium-scale farmers to 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.

Solutions and recommendations

To address these challenges, the following 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.

Learning Tasks

1. Learners define and explain the components of precision agriculture.
2. Learners discuss the importance of precision agriculture in arable crop production.
3. Learners examine the challenges of precision agriculture and how to address them.
4. Learners to experiment with variable rate seeding as an example of precision agriculture.

Pedagogical Exemplars

1. **Collaborative digital learning**
    a. Learners, in small groups, surf the Internet for the meaning and components of precision agriculture, discuss their findings and present reports.
    b. Learners in the same groups, watch video documentaries or pictures on the use of precision agriculture (e.g. automated irrigation system or spot spraying drones) in arable crop production, discuss their findings and present reports.
2. **Structured talk for learning:** Learners in their groups discuss the benefits and challenges of precision agriculture and present their findings to the class. The teacher should guide learners with leading questions and also encourage learners to work in teams.#
3. **Experiential learning:** Learners in the same groups experiment with variable rate seeding (as an example of precision agriculture) in the school garden:
    - Learners plant different numbers of seeds in the same size of small container.
    - Learners observe and record plant height, leaf colour, stalk girth or other suitable characteristics.
    - Learners pool data, analyse statistically and conclude on how seeding rate affects plant growth and development and present their findings to the class.

Key Assessments

Assessment Level 1: Define precision agriculture.

Assessment Level 2: Explain at three specific applications of precision agriculture in arable crop production.

Assessment Level 3: Discuss the importance of precision agriculture in arable crop production.

Assessment Level 4

1. Explain three challenges that could hinder the use of precision agriculture in Ghana and how to address them.
2. In groups, explain orally the role of precision agriculture in arable crop enterprises.

Hint

*The recommended mode of assessment for week 8 is **oral presentation**. Use the level 4 question 2 as a sample question*

Week 9

Learning Indicator: Describe the use and importance of the mini-sett technique in seed yam production

Focal Area: The role of the mini-sett technique in promoting yam production

1. Meaning and objectives of mini-setts technique in 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 25-50 g each with at least one bud (eye) which can sprout and grow into a new plant.

Objectives of mini-sett technique in yam production

a. 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.

b. To minimise wastage of planting material and make the best use of healthy tubers.

c. To increase the number of yam plants per unit area, potentially leading to greater yields.

d. To propagate yam plants from healthy, disease-free mini-setts to reduce the incidence and spread of diseases in yam fields

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

2. Steps involved in using yam mini-sett technique

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

Figure.9.1: *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.

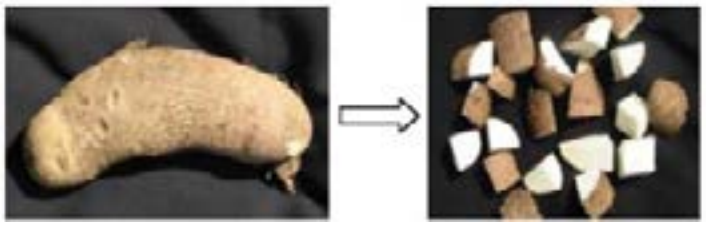

Figure.9.2: *Preparation of mini-setts*

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.9.3: *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.9.4: *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.

3. **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.

4. **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.

Learning Tasks

1. Learners to define the mini-sett technique and state its objectives in yam production.
2. Learners to outline the steps of the mini-sett technique in yam production.
3. Learners to practise the steps of the mini-sett technique in yam production.
4. Learners to discuss the benefits of the mini-sett technique in yam production.

Pedagogical Exemplars

1. **Structured talk for learning:** The teacher gives background information about the mini-sett technique in yam production to learners and guides learners in groups to discuss the meaning and objectives of using the mini-sett technique in yam production.
2. **Experiential learning:** Learners perform the mini-sett technology in seed yam production.
    a. Learners brainstorm to identify the materials needed for the yam mini-sett technology. The teacher guides learners to acquire/assemble the materials. Learners may bring yam tubers from home.
    b. The teacher/technician/resource person demonstrates cutting of the yam tuber into mini-setts.
    c. Learners in groups practise how to cut the yam tuber into mini-setts. Teachers should encourage all learners to take part in cutting the mini-setts. The teacher guides learners to treat the mini-setts with fungicide or wood ash and nurse them in bags/trays with soil/sawdust.
    d. Learners apply ample water to the setup and observe until sprouting.
    e. Learners plant the sprouts onto mounds/ridges or jute sacks/plastic containers and care for them until mature.
3. **Activity-based learning:** Learners in their groups compare the benefits of the mini-sett technique and the traditional method of yam production, and present their findings on cardboard posters and paste them on the wall.

Key Assessments

Assessment Level 1: What is yam mini-setts?

Assessment Level 2: Outline the objectives of the yam mini-sett technique.

Assessment Level 3: Discuss the steps in the yam mini-sett technique.

Assessment Level 4

1. Compare the mini-sett technique with the traditional method of yam production.
2. Use mini-sett technique to produce seed yam and grow it to maturity.

Hint

*The recommended mode of assessment for week 9 is **report writing**. Use the level 4 question 2 as a sample question. Refer to Appendix I at the end of this section for more information on the report writing.*

SECTION 3 REVIEW

Agriculture has gone through several phases with each succeeding phase relying on more improved technology than the previous leading to greater efficiency and productivity. The current phase of agriculture is relying more on precision agriculture which drastically reduces drudgery, maximises scarce resources and reduces the human interface. This section explains the meaning, importance and challenges of precision agriculture in arable crop enterprises and offers farmer-based and governmental solutions to the challenges. Another emerging technology in Ghana is the mini-sett technique. Even though the technology is not very new in Ghana, it is now being extended to farmers. The technology is explained, detailing how it is carried out, and the associated benefits compared with the traditional method of yam cultivation. Experiential pedagogies have been employed to ensure the learners acquire the technique as they engage in hands-on activities. In addition to developing practical knowledge and skills, the learners will also enhance their collaborative skills.

APPENDIX H: RUBRICS FOR THE ORAL PRESENTATION ASSESSMENT TASK

Criteria	Excellent – 4 marks	Good – 3 marks	Satisfactory – 2 marks	Needs Improvement
Introduction	**(Must include all 4 points for 2 marks):** 1. Clearly defines precision agriculture as a technology-driven approach to crop management. 2. Mentions multiple emerging technologies like robotics, machine learning, and big data analytics. 3. Explains how these technologies have transformed modern agriculture on both small and large scales. 4. Highlights the role of precision agriculture in improving efficiency and sustainability in arable crop production	**(Must include any 3 points for 1.5 marks):** 1. Clearly defines precision agriculture as a technology-driven approach to crop management. 2. Mentions multiple emerging technologies like robotics, machine learning, and big data analytics. 3. Explains how these technologies have transformed modern agriculture on both small and large scales. 4. Highlights the role of precision agriculture in improving efficiency and sustainability in arable crop production	**(Must include any 2 points for 1 mark):** 1. Clearly defines precision agriculture as a technology-driven approach to crop management. 2. Mentions multiple emerging technologies like robotics, machine learning, and big data analytics. 3. Explains how these technologies have transformed modern agriculture on both small and large scales. 4. Highlights the role of precision agriculture in improving efficiency and sustainability in arable crop production	**(Must include any 1 point for 0.5 marks):** 1. Clearly defines precision agriculture as a technology-driven approach to crop management. 2. Mentions multiple emerging technologies like robotics, machine learning, and big data analytics. 3. Explains how these technologies have transformed modern agriculture on both small and large scales. 4. Highlights the role of precision agriculture in improving efficiency and sustainability in arable crop production

Content	(Must include all 4 points for 6 marks) 1. Organic Farming Discusses its use of technology to monitor soil health, water use, and pest management, with examples like IoT sensors and real-time soil analysis. 2. Vertical Farming Explains how vertical farms use hydroponics and LED lighting to maximize production in limited spaces, providing examples of urban farming initiatives. 3. Drones Describes drone applications for crop monitoring, irrigation, and pesticide application, citing their ability to improve accuracy and efficiency. 4. Big Data Analytics Highlights how farmers use data-driven insights to optimize planting schedules, manage resources, and predict crop yields with platforms like FarmLogs.	(Must include any 3 of the following points for 4.5 marks) 1. Organic Farming Discusses its use of technology to monitor soil health, water use, and pest management, with examples like IoT sensors and real-time soil analysis. 2. Vertical Farming Explains how vertical farms use hydroponics and LED lighting to maximize production in limited spaces, providing examples of urban farming initiatives. 3. Drones: Describes drone applications for crop monitoring, irrigation, and pesticide application, citing their ability to improve accuracy and efficiency. 4. Big Data Analytics Highlights how farmers use data-driven insights to optimize planting schedules, manage resources, and predict crop yields with platforms like FarmLogs.	(Must include any 2 of the following points for 3 marks) 1. Organic Farming Discusses its use of technology to monitor soil health, water use, and pest management, with examples like IoT sensors and real-time soil analysis. 2. Vertical Farming Explains how vertical farms use hydroponics and LED lighting to maximize production in limited spaces, providing examples of urban farming initiatives. 3. Drones: Describes drone applications for crop monitoring, irrigation, and pesticide application, citing their ability to improve accuracy and efficiency. 4. Big Data Analytics Highlights how farmers use data-driven insights to optimize planting schedules, manage resources, and predict crop yields with platforms like FarmLogs.	(Must include any 1 of the following points for 1.5 marks) 1. Organic Farming: Discusses its use of technology to monitor soil health, water use, and pest management, with examples like IoT sensors and real-time soil analysis. 2. Vertical Farming: Explains how vertical farms use hydroponics and LED lighting to maximize production in limited spaces, providing examples of urban farming initiatives. 3. Drones: Describes drone applications for crop monitoring, irrigation, and pesticide application, citing their ability to improve accuracy and efficiency. 4. Big Data Analytics: Highlights how farmers use data-driven insights to optimize planting schedules, manage resources, and predict crop yields with platforms like FarmLogs.

Conclusion	**(Must include all 4 points for 2 marks)** 1. Increased Efficiency Precision agriculture improves efficiency by automating processes like planting, irrigation, and harvesting. 2. Reduced Labour Costs Automated machinery and technology reduce the need for manual labour, saving time and money. 3. Improved Productivity Tools like drones and data analytics help farmers monitor crop health and maximize yield. 4. Resource Optimization: Technologies like IoT sensors ensure optimal use of water, fertilizers, and pesticides, minimizing waste.	**(Must include any 3 points for 1.5 marks)** 1. Increased Efficiency Precision agriculture improves efficiency by automating processes like planting, irrigation, and harvesting. 2. Reduced Labour Costs Automated machinery and technology reduce the need for manual labour, saving time and money. 3. Improved Productivity Tools like drones and data analytics help farmers monitor crop health and maximize yield. 4. Resource Optimization: Technologies like IoT sensors ensure optimal use of water, fertilizers, and pesticides, minimizing waste.	**(Must include any 2 points for 1 mark)** 1. Increased Efficiency Precision agriculture improves efficiency by automating processes like planting, irrigation, and harvesting. 2. Reduced Labour Costs Automated machinery and technology reduce the need for manual labour, saving time and money. 3. Improved Productivity Tools like drones and data analytics help farmers monitor crop health and maximize yield. 4. Resource Optimization: Technologies like IoT sensors ensure optimal use of water, fertilizers, and pesticides, minimizing waste.	**(Must include any 1 of the following points for 0.5 marks)** 1. Increased Efficiency: Precision agriculture improves efficiency by automating processes like planting, irrigation, and harvesting. 2. Reduced Labour Costs: Automated machinery and technology reduce the need for manual labour, saving time and money. 3. Improved Productivity: Tools like drones and data analytics help farmers monitor crop health and maximize yield. 4. Resource Optimization: Technologies like IoT sensors ensure optimal use of water, fertilizers, and pesticides, minimizing waste.

Summary	(Must include all 4 points for 2 marks): Increased Efficiency: Precision agriculture increases efficiency by integrating automated technologies such as GPS-guided tractors and automated irrigation systems. Automation of Processes: Highlights automation in planting, weeding, and harvesting, with examples like robotic harvesters and smart irrigation systems. Reduced Labour Costs: Explains how automation minimizes manual labour, citing examples such as drones replacing traditional crop monitoring. Improved Productivity: Discusses how tools like big data analytics and precision planting improve crop yields and reduce resource wastage.	(Must include any 3 points for 1.5 marks): Increased Efficiency: Precision agriculture increases efficiency by integrating automated technologies such as GPS-guided tractors and automated irrigation systems. Automation of Processes: Highlights automation in planting, weeding, and harvesting, with examples like robotic harvesters and smart irrigation systems. Reduced Labour Costs: Explains how automation minimizes manual labour, citing examples such as drones replacing traditional crop monitoring. Improved Productivity: Discusses how tools like big data analytics and precision planting improve crop yields and reduce resource wastage.	(Must include any 2 points for 1 mark): Increased Efficiency: Precision agriculture increases efficiency by integrating automated technologies such as GPS-guided tractors and automated irrigation systems. Automation of Processes: Highlights automation in planting, weeding, and harvesting, with examples like robotic harvesters and smart irrigation systems. Reduced Labour Costs: Explains how automation minimizes manual labour, citing examples such as drones replacing traditional crop monitoring. Improved Productivity: Discusses how tools like big data analytics and precision planting improve crop yields and reduce resource wastage.	(Must include any 1 of the following points for 0.5 marks): Increased Efficiency: Precision agriculture increases efficiency by integrating automated technologies such as GPS-guided tractors and automated irrigation systems. Automation of Processes: Highlights automation in planting, weeding, and harvesting, with examples like robotic harvesters and smart irrigation systems. Reduced Labour Costs: Explains how automation minimizes manual labour, citing examples such as drones replacing traditional crop monitoring. Improved Productivity: Discusses how tools like big data analytics and precision planting improve crop yields and reduce resource wastage.

Challenges	(Must include all 4 points for 2 marks)	(Must include any 3 points for 1.5 marks)	(Must include any 2 points for 1 mark)	(Must include any 1 point for 0.5 mark):
	1. System Malfunctions Explains issues like GPS failures or drone crashes and their impact on operations, such as delays in planting or crop monitoring. 2. High Initial Costs Discusses the expense of acquiring and implementing precision technologies like sensors and automated machinery. 3. Technical Knowledge Requirement Highlights the need for farmers to have advanced technical skills to operate and maintain high-tech equipment. 4. Dependence on Connectivity Explains challenges such as unreliable internet or network issues in rural areas that affect the functionality of precision tools.	1. System Malfunctions Explains issues like GPS failures or drone crashes and their impact on operations, such as delays in planting or crop monitoring. 2. High Initial Costs Discusses the expense of acquiring and implementing precision technologies like sensors and automated machinery. 3. Technical Knowledge Requirement Highlights the need for farmers to have advanced technical skills to operate and maintain high-tech equipment. 4. Dependence on Connectivity Explains challenges such as unreliable internet or network issues in rural areas that affect the functionality of precision tools.	1. System Malfunctions Explains issues like GPS failures or drone crashes and their impact on operations, such as delays in planting or crop monitoring. 2. High Initial Costs Discusses the expense of acquiring and implementing precision technologies like sensors and automated machinery. 3. Technical Knowledge Requirement Highlights the need for farmers to have advanced technical skills to operate and maintain high-tech equipment. 4. Dependence on Connectivity Explains challenges such as unreliable internet or network issues in rural areas that affect the functionality of precision tools.	1. System Malfunctions: Explains issues like GPS failures or drone crashes and their impact on operations, such as delays in planting or crop monitoring. 2. High Initial Costs: Discusses the expense of acquiring and implementing precision technologies like sensors and automated machinery. 3. Technical Knowledge Requirement: Highlights the need for farmers to have advanced technical skills to operate and maintain high-tech equipment. 4. Dependence on Connectivity: Explains challenges such as unreliable internet or network issues in rural areas that affect the functionality of precision tools.

Total – 20 marks

APPENDIX I: RUBRIC FOR REPORT WRITING

Report Writing - The Mini-Sett Technique in Yam Production

Task Description

You are required to research and practise the mini-sett technique in yam production, then write a detailed report explaining what you learned. Your report should demonstrate your understanding of the concept, the process involved, its objectives, and its benefits. This task will help you to improve your research, writing, and practical application skills.

Structure of the Report

Your report must follow this structure:

1. Title Page
   - Title of the report (e.g., *A Report on the Mini-Sett Technique in Yam Production*)
   - Your name
   - Class/Group
   - Date of submission
2. Introduction
   - Briefly introduce yam production in Ghana and the importance of modern techniques.
   - State why the mini-sett technique is being researched (e.g., improving yam yields, addressing food security, reducing costs).
   - Mention what your report will cover
3. Definition and Objectives of the Mini-Sett Technique
   - Define the mini-sett technique clearly in your own words.
   - Explain its main objectives (e.g., producing healthy seed yams, reducing wastage, increasing productivity).
4. Steps of the Mini-Sett Technique
   - Present a clear step-by-step outline of how the mini-sett technique is done.
   - Use numbering or bullet points for clarity.
   - You may include simple diagrams or illustrations (optional).
5. Practical Application (What You Did in Class/Field)
   - Describe how you and your classmates practised the mini-sett technique.
   - Write about what materials were used, the process followed, and any challenges faced.
   - Use the first person plural (we) since this was a group activity (e.g., *We cut the yam into small setts and treated them with chemicals*).

6. Benefits of the Mini-Sett Technique
    - Discuss the key advantages (e.g., better use of yam tubers, disease control, cheaper seed yam production, more efficient farming).
    - Relate some of these benefits to Ghanaian farmers and food production.
7. Conclusion
    - Summarize your findings and experiences.
    - State why the mini-sett technique is important for sustainable agriculture.
    - Suggest what farmers can do to adopt the technique more widely.

Expected Output

- A well-structured report of 4–6 pages.
- Clear language, neat presentation, and proper headings.
- A balance between research (definition, steps, benefits) and practical work (application).

Rubric for Report on the Mini-Sett Technique in Yam Production (20 Marks)

Criteria	Excellent (4 Marks)	Good (3 Marks)	Fair (2 Marks)	Needs Improvement (1 Mark)
Introduction & Clarity	Introduction is clear, engaging, and provides strong context for yam production and the mini-sett technique.	Introduction is clear but limited in context.	Introduction is vague and does not fully explain the purpose.	No introduction or very unclear.
Definition & Objectives	Provides accurate definition and explains objectives clearly and fully.	Provides accurate definition and most objectives.	Definition and objectives are incomplete or partly unclear.	Definition and objectives are missing or incorrect.
Steps of the Technique	Steps are listed clearly, logically, and completely; easy to follow.	Steps are mostly complete and logical but with minor gaps.	Steps are incomplete or somewhat unclear.	Steps are missing or very unclear.
Practical Application	Detailed description of class practice; shows clear connection between theory and practice.	Describes class practice with some detail and connection.	Limited description of class practice; weak connection.	No description of class practice included.

Benefits & Discussion	Benefits are well explained, realistic, and linked to Ghanaian context.	Benefits are explained with some connection to context.	Benefits are vague or not well explained.	No benefits discussed.
Conclusion	Strong conclusion summarizing findings and relevance.	Conclusion present but limited in scope.	Conclusion is vague or repetitive.	No conclusion provided.
Organization & Presentation	Report is well-organized, neatly presented, with proper headings and logical flow.	Organization is clear with minor errors in flow or headings.	Report has weak organization and some untidy presentation.	Very poor organization; difficult to follow.

SECTION 4: AGRICULTURAL MACHINERY

Strand: New Dawn Agriculture

Sub-Strand: Agricultural Machinery

Learning Outcome: Explain the roles of farm machinery and equipment in arable crop (cereals, legumes, and tuber crops) production

Content Standard: *Demonstrate knowledge, understanding and skills, in the operation of farm machinery and implements used in arable crop (cereals, legumes, and tuber crops) production.*

Hint

Remind learners to submit the group project in week 11.

INTRODUCTION AND SECTION SUMMARY

Arable crop production involves the cultivation of cereals, legumes and tubers. This requires a range of machinery to efficiently manage the processes of preparing the land, planting, crop management, harvesting and post-harvest operations. The use of machinery in crop production is intended to reduce drudgery in farming and make farming more attractive to young people. This section aims to introduce learners to various types of machinery used in arable crop production. It is crucial that learners understand the different types of machinery and how they operate, including precautions and maintenance, in order to carry out safe and effective farming practices. Learners are expected to have in-depth knowledge of safety guidelines to ensure they operate machinery effectively and safely, contributing to a productive agricultural environment. Teachers are expected to guide learners while performing the various farm operations.

The weeks covered by the section are:

Week 10: Identify and classify different types of machinery used in arable crop (cereals, legumes and tubers) production.

Week 11: Operate different types of machinery used in arable crop production

SUMMARY OF PEDAGOGICAL EXEMPLARS

To teach high school learners to identify, safely operate and maintain machinery for arable crop production requires a combination of interactive, hands-on and theoretical approaches. These will ensure learners understand the safety precautions and can operate and maintain the machines. Teachers should use talk for learning and collaborative learning to guide learners in identifying and classifying farm machinery according to their uses. Exploratory and experiential learning through field visits or fieldwork in the school farm should be deployed to help learners acquire hands-on experience in machinery use and maintenance. Problem-based and project-based learning should be used to assist learners in researching precautions for operating farm machines. Teachers should consider differences in learners' cultural backgrounds, gender and capabilities and structure their pedagogical approaches to benefit everyone. These pedagogical approaches prepare students for future careers in agriculture while instilling a strong sense of responsibility and safety awareness.

ASSESSMENT SUMMARY

Appropriate assessment strategies in teaching and learning are needed to support the growth of learners and promote equity and inclusion. Assessing learners' ability to identify, classify, operate, and maintain farm machinery, can be effectively done using various strategies. A good mixture of these strategies can effectively assess learners' knowledge and skills in these activities. The assessment methods include peer and self-assessment to encourage learners to foster reflection and develop deeper understanding. Quizzes and examinations, including multiple-choice, matching and short answer questions should be used to assess knowledge on the identification and classification of different farm machinery. Learners are also expected to explain the principles of operation and maintenance procedures for specific types of farm machinery. Teachers should provide timely and constructive feedback to help learners improve and update the transcript system with learner's performance records.

Week 10

Learning Indicator: Identify and classify different types of machinery used in arable crop (cereals, legumes and tubers) production

Focal Area 1: Different types of machinery used in arable crop production

1. Identification of different types of machines used in arable crop production. In arable crop production, various types of machines are used to facilitate the different stages of crop cultivation, from soil preparation to harvesting. The different types of machines commonly used include:

   a. Ploughs: Used for primary tillage to turn over the soil, burying crop residues and weeds.

   b. Harrows: To break up clods and provide a finer soil structure. Types include disc harrows, tine harrows, and chain harrows.

   c. Cultivators: For secondary tillage, to stir and pulverize the soil, before planting or during crop growth.

   d. 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 (istockphoto.com)*

   e. 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.10.2: *Seed drills (shutterstock.com/search/seed-drill-machine)*

f. **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.

g. **Broadcast seeders:** They are also known as spreaders and disperse seeds and fertilisers evenly across large fields. Broadcast seeders can be hand-held, tractor-mounted, or tow-behind models. They can be adjusted to allow for control over the rate and spread pattern of seeds and fertilisers. They are fast but less precise than drills or planters, which can lead to uneven distribution of seeds and high seed wastage due to overlap or gaps in coverage.

Figure 4.3: *Hand-held broadcast spreader*

Figure 4.4:*Tractor-mounted tow spreader*

Figure 4.5: *Tractor-operated broadcast spreader*

h. **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 fertilizer 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 4.6: *Walk behind broadcast fertiliser spreader (amazon.com/walk-behind-broadcast-fertiliser-ergonomic-composting/dp/B0C6KD1MR2).*

i. **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 4.7: *Manually-operated knapsack sprayer*

Figure 4.8: *A boom sprayer*

j. **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.

k. **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 4.9: *Two types of combine harvesters*

Figure 4.10: *A combine harvester at work*

l. **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.

m. **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 4.11: *Rice/wheat threshing machine*

n. **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 4.12: *A picture of a tractor and a wagon*

2. 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 their functions and stages of the crop production process.

a. Soil preparation machinery

   i. Ploughs: These are used for primary tillage to turn over soil.
   ii. Harrows: They break up clods and refine soil.
   iii. Cultivators: They stir and pulverize soil for secondary tillage.
   iv. Rotary tillers: These prepare seedbeds with rotating blades.

b. Planting and sowing machinery

   i. Seed drills: They ensure precision planting at correct depth and spacing.
   ii. Planters: They ensure row crop planting at specified intervals.
   iii. Broadcast seeders: These scatter seeds over large areas.

c. Fertiliser application and pest control machinery

   i. Fertiliser spreaders: They distribute fertilisers evenly.
   ii. Sprayers: They are used to apply pesticides, herbicides, and fungicides.

d. Irrigation machinery

   i. Drip irrigation systems: They supply water directly to plant roots.
   ii. Sprinkler systems: They distribute water over crops.

e. Crop maintenance machinery

   i. Cultivators: These control weeds and aerate soil around crops.
   ii. Hoes: They are used for manual and mechanical weed removal.

f. Harvesting machinery

   i. Combine harvesters: They combine reaping, threshing, and winnowing.
   ii. Pickers: Can discriminate between ripe and unripe fruits or crop heads.

g. Post-harvest handling machinery

   i. Grain dryers: They reduce moisture content in grain.

   ii. Threshers: They separate grain from stalks and husks.

   viii. Wagons and trailers: These transport crops from field to storage.

h. General machinery

   i. Tractors: These are versatile machines for pulling and operating implements.

   ii. Loaders: These are used to move soil, manure, and other materials.

Learning Tasks

1. Learners to identify different types of machinery used in arable crop production.
2. Learners to explain the benefits of using the different types of machinery for arable crop production.
3. Learners to classify different types of machinery used in arable crop production.

Pedagogical Exemplars

1. **Talk for learning**

The teacher guides learners to use multimedia presentations with images, videos, pictures and diagrams of different types of farm machinery and identify the machines and their functions. Leaners should be encouraged to ask questions and take part in discussions.

2. **Exploratory learning**

The teacher organises visits to local farms or agricultural machinery dealers for real-world experience in machinery use. The teacher may invite farmers, agricultural engineers, or machinery dealers to speak about their machinery. Learners should be encouraged to participate in question and answer sessions to learn from experts' insights. The teacher should ask more able learners to research different types of machinery and present their findings to the class using PowerPoint.

3. **Collaborative learning**

The teacher guides learners to classify the machines observed based on their uses and other criteria. Learners should be encouraged to think critically and apply the knowledge acquired earlier.

4. **Experiential learning**

The teacher assigns group projects for learners to research, identify and present on different types of machinery. Learners should be encouraged to foster teamwork and peer learning through collaborative activities.

Key Assessments

Assessment Level 1: List five types of machinery used in arable crop production.

Assessment Level 2: Select the types of machinery used in planting, harvesting and post-harvest activities in the production of maize and yams.

Assessment Level 3

1. Explain the benefits of using cultivators and drills for arable crop production.
2. Classify the following machines:

Ploughs, Harrows, Cultivators, Rotary tillers, Seed drills, Planters, Broadcast seeders, Fertiliser spreaders, Sprayers, Cultivators, combine harvesters, Grain dryers, Threshers, Wagons and trailers under the following:

a. Soil preparation machinery
b. Planting and sowing machinery
c. Fertiliser application and pest control machinery
d. Irrigation machinery
e. Crop maintenance machinery
f. Harvesting machinery
g. Post-harvest handling machinery
h. General machinery

Assessment Level 4: Discuss the role of combine harvesters in cereal production in Ghana.

Hint

*The recommended mode of assessment for week 10 is **peer assessment**. Use the level 3 question 2 as a sample question.*

Week 11

Learning Indicator: Operate different types of machinery used in arable crop production

Focal Area 1: Operating different types of machinery for arable crop production

1. **Precautions for operating farm machines:** Operating farm machines involves several precautions to ensure safety and efficiency.

   Key precautions

   a. Operating manuals and guidelines: All operators should know and follow these guidelines.

   b. Training and certification: All operators should be trained and certified in the operation of farm machinery, including emergency procedures and maintenance.

   c. 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.

   d. 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.

   e. 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.

   f. Work environment safety: Keep work areas clean and free of obstructions. Ensure good lighting in areas where machinery is operated.

   g. Emergency preparedness: A first aid kit and fire extinguisher should be readily available. Establish and communicate emergency procedures to all workers.

   h. Proper storage and transport: Store machines properly when not in use to prevent unauthorized access and damage. Ensure machines are properly secured during transport to forestall accidents.

   i. Awareness of surroundings: Be aware of other workers when operating machinery. Use mirrors and cameras if available to improve the visibility around machines.

   j. Communication: Maintain clear communication with other workers, especially when performing tasks that require coordination.

2. **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

   a. 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.

b. Scheduled servicing: The manufacturer-recommended servicing schedules should be followed for each machine, including changing oil, filters, and lubrication.

c. 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.

d. Lubrication: Lubricate moving parts regularly, such as bearings, gears, and chains. Use the correct type and amount of lubricant to prevent damage.

e. Scheduled maintenance: The manufacturer's schedule for routine maintenance, such as spark plug replacement and belt replacements should be followed.

f. 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.

g. Tyre pressure: Check tyre pressures regularly to maintain the recommended pressure for optimal traction and fuel efficiency.

h. Worn parts: Replace worn-out or damaged parts promptly with genuine spares to maintain performance and safety.

i. Record keeping: Keep detailed and accurate records of maintenance activities, repairs, parts replacements and inspections to track machine history and plan for future maintenance.

j. Pre-season preparation: Machines should be inspected and prepared for specific tasks such as planting or harvesting before each season begins.

k. Performance monitoring: Regularly monitor machine performance during operation to detect any signs of malfunction early on.

l. Professional assistance: Only authorised service professionals should be consulted when in doubt or for complex repairs.

3. **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 is variable because of inappropriate use. Learners need to know how to use the sprayer correctly, to reduce the misuse and abuse of pesticides.

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

   i. Sprayers come in different types, with varying tank sizes and delivery rates.

   ii. Sprayer nozzles also differ in type, size and emission rate.

   iii. 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.

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

b. **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.

i. Items required for making the calibration stick:

- Knapsack sprayer
- Pegs
- Planting rope (garden/guiding line)
- Garden tape
- Dry, straight, wooden rod
- Clean water in jugs
- 1.0 or 0.5-litre beaker/measuring cylinder
- Indelible marker

ii. The process of making the calibration stick

- Place sprayer on level ground
- Mark out the sprayer base on the ground. All subsequent sprayer readings will be taken from the same spot.
- Fill the sprayer with water one litre or half a litre at a time.
- Each time, dip the rod into the tank and mark the water level on the stick with the indelible marker.
- Repeat until the sprayer tank is filled (15 or 30 marks on the stick).
- Calibration stick is now ready for use.

c. **Spray volume calibration**

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

ii. 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.

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

iv. Peg the opposite side of the baseline.

v. Stretch the garden line along the pegs on the two sides of the field.

vi. Put some clean water into the sprayer tank.

vii. Determine the water volume in the tank with the calibration stick.

viii. Mount the sprayer and spray the water along the garden lines representing the crop rows.

ix. Maintain constant sprayer pressure and walking speed until the area is covered.

x. Dismount the sprayer and dip the calibration stick to determine the volume of water used to cover 100 m^2

xi. Repeat the process at least two times and find the average volume of water used.

xii. Extrapolate to the volume of water ha^{-1} using the relation:

[Ha (m^2)/area treated (m^2)] x (vol. of water used to spray treated area)

= (10,000m^2/100m^2) x ***V***

d. **Quantity of pesticide needed per hectare**

- Most manufacturers indicate the amount of active ingredient (AI) per litre of the formulated product on the container e.g. 40 EC
- 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
- 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.
- From this, the amount of the chemical needed per litre of water can be calculated.

e. **Basic precautions when applying pesticides**

i. Avoid spraying during peak flowering to encourage pollinators, otherwise use selective pesticides which are not harmful to insect pollinators.

ii. Keep sprayer nozzle 30-40 cm above the crop canopy for good coverage.

iii. Keep sprayer pressure high throughout spraying.

iv. Replace respirator and sprayer filters regularly.

v. Respirator filters must be changed if one can smell pesticide through it while spraying.

Teachers should take learners through these steps to reduce pesticide overdose and underdose.

Learning Tasks

1. Identify precautions taken when operating farm machines.
2. Explain the need to take precautions when operating farm machines.
3. Operate a knapsack sprayer.
4. Maintain simple farm machines.

Pedagogical Exemplars

1. **Problem-based learning:** In mixed-ability groups, learners brainstorm the precautions for using farm machinery. The teacher should use videos/pictures to guide learners to identify the precautions. The teacher can invite a resource person to discuss the precautions. Learners should discuss the need for these precautions.
2. **Problem-based learning:** In mixed-ability groups, learners practise calibration and use of the knapsack sprayer. The teacher should identify an area of open land or a playing field to give learners the opportunity to use a knapsack sprayer.

3. **Experiential learning**

In the first instance, the teacher leads learners to a large-scale farm (where available) to watch demonstrations on the precautions and maintenance of farm machinery. Teachers should ensure that all the safety protocols on the farm are strictly adhered to.

The teacher leads learners in their groups to operate the available farm machinery. Learners who have difficulties in performing the activities should be assisted.

Where large-scale farms or machinery stores are not available, learners should download video documentaries on the operation of farm machines, and watch and acquaint themselves with the procedures. The teacher should provide the relevant web links for the videos and be certain the videos used are not gender biased.

Key Assessments

Assessment Level 1: List three precautions to be taken before and during operating farm machines.

Assessment level 2: Explain three precautions employed during the operation of a farm machine.

Assessment Level 3: Outline the calibration of a knapsack sprayer.

Assessment Level 4

1. Discuss two maintenance measures performed after the use of a farm machine.
2. Visit an arable crop farm or watch a video on how to operate at least one type of machinery used in arable crop production like a sprayer or cultivator and write a report.

Hint

*The recommended mode of assessment for week 11 is **field trip**. Use the level 4 question 2 as a sample question.*

SECTION 4 REVIEW

The section introduced learners to different types of farm machinery used in arable crop production and how to operate these machines safely and maintain them. Five main groups of farm machinery were identified for arable crop production. These are soil preparation, planting and sowing, fertiliser application, irrigation and harvesting machinery. Learners were also exposed to the precautions and maintenance of machinery. Some precautions include following instructions from the operating manuals, safe operating procedures, wearing appropriate PPE and emergency preparedness. Maintenance activities include regular inspection for wear and tear, checking tyre pressure, lubricating of moving parts and following servicing schedules. Learners practised the knapsack sprayer calibration for pest and disease control and foliar fertiliser application. The pedagogical approaches would prepare students for the world of work in agriculture while instilling a strong sense of responsibility and confidence in the learners.

APPENDIX J: MARKING SCHEME FOR THE PEER ASSESSMENT TASK

a. Soil preparation machinery
   i. Ploughs.
   ii. Harrows
   iii. Cultivators
   iv. Rotary tillers (1 mark for each)

b. Planting and sowing machinery
   i. Seed drills
   ii. Planters
   iii. Broadcast seeders (1 mark for each)

c. Fertiliser application and pest control machinery
   i. Fertiliser spreaders
   ii. Sprayers (1 mark for each)

d. Irrigation machinery
   i. Drip irrigation systems
   ii. Sprinkler systems (1 mark for each)

e. Crop maintenance machinery
   i. Cultivators
   ii. Hoes (1 mark for each)

f. Harvesting machinery
   i. Combine harvesters
   ii. Pickers (1 mark for each)

g. Post-harvest handling machinery
   i. Grain dryers
   ii. Threshers
   iii. Wagons and trailers (1 mark for each)

h. General machinery
   i. Tractors
   ii. Loaders (1 mark for each)

Total – 20 marks

APPENDIX K: RUBRICS FOR THE FIELD TRIP ASSESSMENT TASK

Report on field trip to an arable crop farm. It should contain the following format and ideas:

Brief introduction: The purpose and importance of the field trip

Main body: this should include all the key steps needed to operate a particular machine

Like the operation of knapsack sprayer to apply insecticide on arable crops.

Steps

Criteria	EXCELLENT (4 MARKS)	VERY GOOD (3 MARKS)	GOOD (2 MARKS)	NEED IMPROVEMENT
Introduction	All 4 points for 4 marks i. Purpose The field trip aimed to understand the practical use of machinery in arable crop farming. ii. Significance Demonstrates the importance of operating machinery like the knapsack sprayer to improve efficiency. iii. Connection: Highlights the transformative role of machinery in modern farming. iv. Relevance Links the field trip to increasing productivity in arable crop enterprises.	Any 3 points for 3 marks i. Purpose The field trip aimed to understand the practical use of machinery in arable crop farming. ii. Significance Demonstrates the importance of operating machinery like the knapsack sprayer to improve efficiency iii. Connection: Highlights the transformative role of machinery in modern farming. iv. Relevance Links the field trip to increasing productivity in arable crop enterprises.	i. Any 2 points for 2 marks ii. Purpose The field trip aimed to understand the practical use of machinery in arable crop farming. iii. Significance Demonstrates the importance of operating machinery like the knapsack sprayer to improve efficiency iv. Connection: Highlights the transformative role of machinery in modern farming. v. Relevance Links the field trip to increasing productivity in arable crop enterprises.	i. Any 1 point for 1 mark ii. Purpose The field trip aimed to understand the practical use of machinery in arable crop farming. iii. Significance Demonstrates the importance of operating machinery like the knapsack sprayer to improve efficiency iv. Connection: Highlights the transformative role of machinery in modern farming. v. Relevance Links the field trip to increasing productivity in arable crop enterprises.

Description of Steps	i. Measure Measures the required amount of insecticide accurately. ii. Mix: Mixes the insecticide thoroughly with water in the sprayer tank according to label instructions. iii. Tool: Uses a stick or similar tool to ensure complete mixing. iv. PPE: Wears appropriate protective equipment (e.g., gloves, goggles).	i. Measure Measures the required amount of insecticide accurately. ii. Mix: Mixes the insecticide thoroughly with water in the sprayer tank according to label instructions. iii. Tool: Uses a stick or similar tool to ensure complete mixing. iv. PPE: Wears appropriate protective equipment (e.g., gloves, goggles).	i. Measure Measures the required amount of insecticide accurately. ii. Mix: Mixes the insecticide thoroughly with water in the sprayer tank according to label instructions. iii. Tool: Uses a stick or similar tool to ensure complete mixing. iv. PPE: Wears appropriate protective equipment (e.g., gloves, goggles).	i. Measure Measures the required amount of insecticide accurately. ii. Mix: Mixes the insecticide thoroughly with water in the sprayer tank according to label instructions. iii. Tool: Uses a stick or similar tool to ensure complete mixing. iv. PPE: Wears appropriate protective equipment (e.g., gloves, goggles).
Filling the Sprayer	i. Open Tank Opens the tank carefully to avoid spillage. ii. Fill: Fills the tank with the prepared solution without overfilling. iii. Check Ensures no leaks before securing the lid. iv. Safety Handles the solution with care.	i. Open Tank Opens the tank carefully to avoid spillage. ii. Fill: Fills the tank with the prepared solution without overfilling. iii. Check Ensures no leaks before securing the lid. iv. Safety Handles the solution with care.	i. Open Tank Opens the tank carefully to avoid spillage. ii. Fill: Fills the tank with the prepared solution without overfilling. iii. Check Ensures no leaks before securing the lid. iv. Safety Handles the solution with care.	i. Open Tank Opens the tank carefully to avoid spillage. ii. Fill: Fills the tank with the prepared solution without overfilling. iii. Check Ensures no leaks before securing the lid. iv. Safety Handles the solution with care.

Spraying	i. Pump Builds adequate pressure in the tank using the handle. ii. Spray Technique Sprays evenly across crops, ensuring full coverage. iii. Maintain Pressure Continuously pumps to maintain consistent pressure. iv. Safety Maintains safety measures while spraying.	i. Pump Builds adequate pressure in the tank using the handle. ii. Spray Technique Sprays evenly across crops, ensuring full coverage. iii. Maintain Pressure Continuously pumps to maintain consistent pressure. iv. Safety Maintains safety measures while spraying.	i. Pump Builds adequate pressure in the tank using the handle. ii. Spray Technique Sprays evenly across crops, ensuring full coverage. iii. Maintain Pressure Continuously pumps to maintain consistent pressure. iv. Safety Maintains safety measures while spraying.	i. Pump Builds adequate pressure in the tank using the handle. ii. Spray Technique Sprays evenly across crops, ensuring full coverage. iii. Maintain Pressure Continuously pumps to maintain consistent pressure. iv. Safety Maintains safety measures while spraying.
Post-Spraying & Waste Disposal	i. Clean Washes tank, nozzle, and wand thoroughly. ii. Dispose Disposes of leftover solution according to regulations. iii. Store Stores the sprayer in a safe, dry place. iv. Prevent Contamination Ensures no environmental harm during disposal.	i. Clean Washes tank, nozzle, and wand thoroughly. ii. Dispose Disposes of leftover solution according to regulations. iii. Store Stores the sprayer in a safe, dry place. iv. Prevent Contamination Ensures no environmental harm during disposal.	i. Clean Washes tank, nozzle, and wand thoroughly. ii. Dispose Disposes of leftover solution according to regulations. iii. Store Stores the sprayer in a safe, dry place. iv. Prevent Contamination Ensures no environmental harm during disposal.	i. Clean Washes tank, nozzle, and wand thoroughly. ii. Dispose Disposes of leftover solution according to regulations. iii. Store Stores the sprayer in a safe, dry place. iv. Prevent Contamination Ensures no environmental harm during disposal.

Conclusion	i. Summarizes all steps clearly. ii. Reflects on the practical importance of learning machinery operation. iii. Emphasizes the benefits of using machinery in arable farming. iv. Connects the experience to modern agricultural practices.	i. Summarizes all steps clearly. ii. Reflects on the practical importance of learning machinery operation. iii. Emphasizes the benefits of using machinery in arable farming. iv. Connects the experience to modern agricultural practices.	i. Summarizes all steps clearly. ii. Reflects on the practical importance of learning machinery operation. iii. Emphasizes the benefits of using machinery in arable farming. iv. Connects the experience to modern agricultural practices.	i. Summarizes all steps clearly. ii. Reflects on the practical importance of learning machinery operation. iii. Emphasizes the benefits of using machinery in arable farming. iv. Connects the experience to modern agricultural practices.

Total – 20 marks

NB: Learners' ability to demonstrate mastery of the above steps in their report should be scored as excellent, very good, good and satisfactory based on the accuracy.

SECTION 5: PRODUCING CROPS FOR INCOME

Strand: Farming for Jobs and Incomes

Sub-Strand: Agricultural Machinery

Learning Outcome: Describe the role of farm machinery in profit-oriented arable crop production (cereals, legumes and tubers)

Content Standard: *Demonstrate knowledge and understanding of market-oriented production of arable crops (cereals, legumes and tubers).*

Hint

Remind learners of the end of semester examination in week 12. Refer to Appendix L at the end of this section for Table of specification.

INTRODUCTION AND SECTION SUMMARY

Arable crop production involves a series of activities that ensure successful cultivation. This process can be broadly categorised into market needs, pre-planting, planting and post-planting activities, harvesting and post-harvest operations. This section aims to introduce learners to the activities involved in the various stages of arable crop production to equip them with detailed knowledge and skills needed to perform these activities successfully. By understanding and applying these stages, learners can appreciate the comprehensive process of arable crop production, which is vital for food security and economic development in Ghana. Teachers are expected to help learners gain adequate insight into modern and efficient ways of performing these activities. This will benefit learners and farmers in Ghana since this helps them to make informed decisions on how to produce crops efficiently in order to maximise profitability and meet consumer demands.

The weeks covered by the section are:

Week 12: Identify market needs for arable crops (cereals, legumes, and tuber crops).

Week 13: Produce at least one arable crop each from among cereals, legumes and tubers.

Week 14: Produce at least one arable crop each from among cereals, legumes and tubers.

Week 15: Carry out required post-harvest practices and market crops produced.

SUMMARY OF PEDAGOGICAL EXEMPLARS

Introducing the market needs of arable crops, pre-planting, planting and post-planting activities, harvesting and post-harvest operations to senior high school learners in Ghana requires engaging them in practical and interactive pedagogical exemplars. To present these concepts effectively, these structured pedagogical approaches should be used. Exploratory learning will

help learners discover the market needs of arable crops through community and market visits to interact with farmers and vendors of arable crops. Talk for learning and collaborative learning will better explain the challenges and strategies in marketing arable crops. Experiential and project-based learning should be used to teach pre-planting and planting activities to help learners have enough hands-on experience. Collaborative digital and experiential learning should be employed in teaching post-harvest operations to assist learners in identifying and practising them. Teachers should factor in the varying needs of all learners in deploying these approaches to help them benefit fully from the lessons.

ASSESSMENT SUMMARY

Various assessment strategies can be used to effectively assess learners' understanding and skills in arable crop production. These strategies should evaluate both theoretical knowledge and practical skills. By combining these assessment strategies, teachers can appraise learners' knowledge and skills in arable crop production, ensuring they are well-prepared for academic success and practical application. Learners should make group presentations on their market research findings, demonstrating their understanding of market demands and consumer preferences. Teachers should assess learners' ability to perform land preparation tasks through hands-on demonstrations in a school garden or farm setting. Use checklists to evaluate learners' planting techniques and adherence to best practices during practical sessions. Employ summative assessments, including final projects, written examinations and reports, to estimate overall learners' performance at the end of the teaching period. Give learners feedback on their performance and update the transcript system.

Week 12

Learning Indicator: Identify market needs for arable crops (cereals, legumes, and tuber crops)

Focal Area 1: Market needs for arable crop produce

1. **Determination of market needs for arable crop production**

Conducting a market assessment for arable crop produce involves evaluating various factors influencing the demand, supply, and overall market dynamics. It should be a 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:

a. Market demand: Identify the demand for specific crops, including volume, quality and timing. This will help farmers to produce the required quantities for profit.

b. Consumer preferences: Farmers should understand consumer preferences for sustainable production e.g. organic, non-GMO and specialty crops.

c. Industry requirements: Producers need to know the raw material needs of industries such as food processing, animal feed and biofuels. This will help farmers target their production to avoid waste and storage challenges.

d. Market trends: Analyse market trends to identify changes in consumer behaviour, technological advancements, and environmental concerns.

e. Competitor analysis: Assess the competition in the market, including their strengths, weaknesses and market share. This will enable farmers to identify the gaps in the market and strategically produce to be competitive.

f. Price analysis: Determine the market price for specific crops, including fluctuations and trends. This will help farmers adjust prices and also produce strategically to be competitive.

g. Supply analysis: Evaluate the current production levels of various arable crops by analysing historical data to identify trends in production volumes.

h. Supply chain efficiency: Evaluate the efficiency of the supply chain, including logistics, transportation, and storage. This helps producers determine whether demands can be met from nearby production centres.

i. Regulatory environment: Consider government policies, regulations, and subsidies that impact arable crop production and trade. This enables farmers to make informed decisions about their production.

j. Market information system: Analyse market trends, consumer behaviour, and supply chain efficiency to help farmers make informed decisions on what to plant and when to sell.

k. Profit margins: Determine profitability based on current market prices and production costs.

2. **Challenges associated with marketing arable crops in Ghana**

Marketing arable crops in Ghana 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:

a. **Poor transportation networks:** The roads in many rural areas in Ghana are poor, making it difficult to transport crop produce to markets. This causes delays, increased transportation costs, crop spoilage and heavy post-harvest losses.

b. **Inadequate storage facilities:** Many storage facilities in the crop-producing areas are 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 to avoid spoilage and waste.

c. **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.

d. **Price fluctuations:** Crop prices are highly volatile in Ghana, influenced by weather conditions, market trends and local supply and demand dynamics. This affects farmers' profit margins.

e. **Inconsistent policies:** Frequent changes in agricultural policies can create uncertainty and hinder long-term planning. Inconsistent policies on subsidies, tariffs, and import/export regulations negatively affect market stability.

f. **Limited market information:** Farmers often lack access to timely and accurate market information. This affects their ability to make decisions about what to grow and when to sell.

g. **Middlemen dominance:** The presence of middlemen erodes farmers' profits, as they often control the market and take a significant share of the earnings.

h. **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 accessing the international market.

i. **Poor pest and disease management:** Inadequate pest and disease control measures lead to significant crop losses, reducing the quality and quantity of produce available for marketing.

j. **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.

3. **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

a. **Market diversification:** Farmers should endeavour to reach various markets with their produce – local, regional, and international markets.

b. **Value addition:** Invest in processing facilities to convert raw crops into higher-value products (e.g. milling maize into flour, or processing soya beans into oil). This improves farmers' access to markets and their profit margins.

c. **Branding:** Developing strong brands for arable crops enhances product market appeal. Branding includes packaging, unique selling propositions indicating quality, organic production, or fair-trade practices.

d. **Cooperative marketing:** Farmer groups can pool resources to increase bargaining power, and access larger markets.

e. **Direct marketing:** Producers can 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.

f. **Quality improvement:** Resorting to the best agronomic practices, post-harvest handling and quality control ensure produce meets market standards.

g. **Market information system:** Systems that provide farmers with real-time market information on prices, demand and supply trends enable farmers to get maximum profit.

h. **Financial services:** Farmers who access affordable credit and microfinance invest in better inputs and technology. The government should 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.

i. **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.

j. **Private sector partnerships:** Farmers should partner with private sector companies for investment, technology transfer and market access. Farmers can also collaborate with NGOs and development agencies for capacity building, funding and technical assistance to enhance production and marketing of their produce.

Learning Tasks

1. Learners to identify market needs for arable crop production through a visit to the community and the local markets.
2. Learners to discuss the challenges faced in marketing arable crops in Ghana.
3. Learners to analyse strategies to adopt to market arable crops to improve farmers' profit margins

Pedagogical Exemplars

1. **Exploratory Learning:** Put learners in mixed ability groups and take them to visit the community and the local markets, to check for the types of arable crops being sold and related market needs and challenges farmers face in marketing these crops.
2. **Talk for Learning:** Learners in their original groups discuss their findings and present a group report to the class.
3. **Collaborative Learning:** Learners work in groups to identify and discuss various strategies to market arable crops to improve farmers' profit margins. Teachers should support learners with leading questions and encourage learners' active participation. Learners should present their findings to the class.

Key Assessments

Assessment Level 1: State four market needs that influence arable crop production.

Assessment Level 2: Explain how the assessment of market needs for arable crops helps their production and marketing.

Assessment Level 3: Discuss four challenges farmers faced in marketing arable crops.

Assessment Level 4: Analyse three strategies for marketing arable crops to boost profit margins of farmers.

Hint

The recommended mode of assessment for week 12 is end of semester examination. Refer to Appendix L at the end of this section for Table of specification.

WEEK 13

Learning Indicator: Produce at least one arable crop from cereals, legumes and tubers

Focal Area: Production of selected arable crops

1. **Pre-planting activities**

Well-planned and executed pre-planting activities in arable crop production create optimal conditions for crop germination, emergence, establishment, growth and yield. These activities ensure the soil is well prepared, nutrients are available, and potential problems are identified and mitigated before planting. Bellow are the key pre-planting activities

a. **Site selection and soil testing**

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

i. Soil type and quality: Soil type and quality directly affect crop growth and yield.

- Soil texture: Loamy soils are generally preferred as they have good drainage and nutrient-holding capacity.
- Soil fertility: Ensure the soil has adequate essential nutrients.
- pH levels: Most crops grow best in soils of neutral pH (6.0-7.5), but specific crops have different requirements.
- Drainage: Well-drained soils prevent waterlogging, which damages crops.

ii. Water availability: Reliable water sources are essential for irrigation. Consider the following

- 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, should there be the need for irrigation.
- Water quality: Water should be free from contaminants and suitable for irrigation.
- Irrigation infrastructure: Type, availability and condition of irrigation systems.

iii. Climate and weather conditions: The climate must be suited for the chosen crops. The following factors play important roles:

- Temperature: Ensure the temperature range is appropriate for the chosen crops.
- Rainfall: Adequate and well-distributed rainfall is crucial. Consider irrigation if rainfall is insufficient.
- Wind: High winds can cause soil erosion and damage to crops.

iv. Topography: The physical layout of the land affects water runoff and soil erosion. Hence the slope and elevation must be considered when selecting a farming site.

- Slope: Gentle slopes are preferred to prevent erosion and facilitate the use of machinery.

- Elevation: Higher elevations might have cooler temperatures and different microclimates and therefore only suitable for certain crops.

v. **Proximity to markets and infrastructure:** Reduces transportation costs and facilitates market access. Consider the following

- Distance to markets: The closer the market the less transportation costs and time.
- Availability of storage facilities: Proper storage facilities help preserve the quality of the produce.

vi. **Farm accessibility:** The site should have good road networks for faster and easier movement of machinery and produce.

vii. **Labour availability:** Adequate workforce is needed for various farming operations. Consider the following

- Local workforce: Availability of skilled and unskilled labour in the vicinity.
- Cost of labour: Ensure labour costs are within budget.

b. Soil testing: How to determine soil fertility status

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

ii. Put all samples together (composite) and mix thoroughly.

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

iv. Interpret results to guide soil amendment decisions.

2. **Selection of crop variety**

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

a. Climate and weather conditions: Crop varieties have specific temperature, rainfall, and humidity requirements. Choose varieties that can withstand the local conditions including extremes.

b. 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.

c. Availability and seed quality: High-quality seeds are essential for good germination and vigorous growth. Ensure seeds are from reputable suppliers and check germination rate and seed health before planting.

d. 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.

e. Pest and disease resistance: Choose crop varieties resistant to common pests and diseases in the area to reduce losses and ensure high yields.

f. **Maturity period:** Ensure 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.

g. **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

h. **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.

i. **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.

3. **Seed treatment:** Protect seeds from pests and diseases to enhance germination.

    a. Treat seeds with fungicides, insecticides, or bio-control agents such as the bacteria *Bacillus* and *Pseudomonas* spp. and the fungus *Trichoderma* spp.

    b. All seeds coated with synthetic pesticides must be handled with care.

4. **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 germinability are sown, laying the foundation of a successful crop. Here is a guide to conducting a germination test and recording the percentage of germination:

    a. **Materials needed for a germination test**

        i. Seeds to be tested

        ii. Paper towels or filter paper

        iii. Water

        iv. Plastic bags or containers

        v. Labels

        vi. Pen and notebook

    b. **Steps**

        i. 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.

        ii. Setup preparation

        - 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.
        - 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.
        - 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.

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

iv. **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).

c. **Determining percentage germination**

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

ii. **Percentage germination:** Use the formula: Percentage germination = (Number of germinated seeds/total number of seeds tested) × 100

iii. **For example:** If 95 seeds were tested and 85 of them germinated, then: Percentage Germination = (85/95) × 100 = 89.5 %

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

- Date of the test
- Seed type and batch number
- Total number of seeds tested
- Number of seeds germinated
- Percentage germination
- Observations (e.g. any abnormalities in seedling growth)

5. **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:

a. Land clearing: Remove vegetation, debris, stones, and other obstacles. Use manual tools (like machetes and hoes) or mechanical equipment (like tractors and bulldozers) for clearing.

b. Tillage: Soil tillage refers to the mechanical cultivation of the soil to prepare it for planting. The tillage processes involve the following

i. Primary tillage: This involves deep ploughing or digging to break up the soil and incorporate organic matter. It helps in improving soil aeration, water infiltration and weed control. Ploughing uses mouldboard, disc, or chisel ploughs to turn over the soil.

ii. 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.

- Harrowing: Using disc harrows or tine harrows to break soil clods.
- Rotary tilling: Using rototillers to achieve a fine tilth.

c. Levelling

i. A level field ensures uniform water distribution and easier irrigation and drainage.

ii. Use land planes or equipment for levelling large fields or manual levelling tools for smaller plots.

c. Ridging and mounding: Ridges and mounds are used in agriculture to improve crop growth.

i. 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.

ii. 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.

6. **Lining and pegging for planting**

Lining and pegging for planting arable crops ensures planting in an orderly manner.

a. Lining: Lining ensures rows and spacing are accurate before planting. This step maximises space utilization, ensuring proper plant growth, and facilitating subsequent farm operations like weeding, irrigation, and harvesting.

i. Steps in lining and pegging

- **Field measurement:** Measure the field to determine the planting area.
- **Establishing baselines:** Identify the base of the field i.e. the side from which planting should start. Stretch a garden line along the base. The 6-8-10 (Pythagoras) theorem ensures a straight baseline.
- **Marking rows**
  - Mark the inter-row spacing based on the crop's requirements, e.g. 80 cm for maize and 60 - 75 cm for cowpeas.
  - Stretch a garden line and tape along the field base to mark the desired row spaces.
  - Fix pegs at the marked points.

ii. Benefits of lining and pegging

- **Optimal space utilisation:** Ensures plants have enough space to grow without competition for resources.
- **Facilitates farm operations:** Makes agronomic practices (weeding, pest monitoring, fertiliser and pesticide application and harvesting) easier and more efficient.
- **Aesthetic appeal:** Results in a neat and organised field layout.

7. **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.

   a. Dibbling: Seeds are manually placed in small holes made with different implements including hoes, sticks and cutlasses, and covered. This is done without attention to spacing and seed depth in the soil.

   Advantage: Suitable for large seeds like beans and maize.

   Disadvantages

   i. Labour-intensive and slow.

   ii. Not suitable for large-scale planting.

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

   Advantages

   i. The method is simple and quick.

   ii. Suitable for small seeds and crops like grasses and legumes.

   iii. Large fields can be sown in a relatively short time.

   Disadvantages

   i. Uneven seed distribution can occur.

   ii. Requires an additional operation like harrowing to cover up seeds with soil.

   iii. Higher seed rate required due to potential wastage.

   c. 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 vary widely according to planting device and equipment

   i. Manual row planting: Seeds are sown with sticks, cutlasses and hoes. Seed depth is highly variable resulting in uneven seedling emergence

      Advantages

      - Allows for easy mechanized cultivation and harvesting.
      - Ensures optimal plant population and resource use.

      Disadvantages

      - More labour-intensive if done manually.
      - Requires careful planning and execution.

   ii. Drill sowing: 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

- Precise seed spacing and depth.
- Efficient use of seeds with lower seed rates.
- Facilitates mechanized weeding
- Easier field operations.

Disadvantages

- Requires a costly seed drill.
- Not suitable for small or uneven fields.

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

Advantages

- Maximises seed use efficiency and ensures uniform plant spacing.
- Ideal for high-value crops where precision is critical.

Disadvantages

- Requires sophisticated and expensive equipment.
- May require skilled labour for operation.

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

Advantages

- Only healthy seedlings are transplanted.
- Good establishment, optimum crop density and vigorous growth of seedlings.
- Allows for better crop timing and season extension.

Disadvantages

- Labour-intensive and time-consuming.
- Requires additional infrastructure like nurseries or greenhouses.

8. **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 is a guide on how to determine percentage emergence

- Note the number of seeds sown
- Count seedlings emerged and note the number
- Calculate percentage emergence thus,

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

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

Factors that influence seedling emergence from the soil

a. **Seed quality and viability:** Seedling emergence depends on the viability and quality of the seed.

b. **Soil moisture:** Adequate soil moisture is essential for seed germination and emergence. Germination and emergence may fail in soggy soil.

c. **Soil temperature:** Optimal soil temperature for seed germination and emergence varies with the crop and the variety.

d. **Soil texture and structure:** Well-draining, loose soil improves seedling emergence.

e. **Planting depth:** Seeds planted too deep may exhaust their energy reserves before reaching the surface.

f. **Soil compaction:** Compacted soil hinders seedling emergence.

g. **Soil salinity and pH:** Extreme soil salinity and pH delay or prevent seedling emergence.

h. **Plant residue and mulch:** Excessive plant residue or mulch impedes seedling emergence.

i. **Pest and diseases:** Pests and diseases damage seeds and seedlings, reducing emergence.

j. **Planting time:** Planting at the optimal time for the specific crop and region can improve emergence.

Learning Tasks

1. Learners to grow a selected arable crop and make a list of pre-planting and planting activities.
2. Learners experiment to determine the germination percentage for seeds.
3. Learners experiment to determine the percentage of seedling emergence.
4. Learners to practise and discuss the relevance of all pre-planting and planting activities.

Pedagogical Exemplars

1. **Experiential learning:** Learners in mixed-ability groups select an arable crop to grow and identify the pre-planting and planting activities performed when cultivating the selected arable crop. Teachers should guide learners to perform these activities as they visit regularly and take records for discussion in class.

   a. Learners carry out germination tests and record percentage germination.

   b. Learners wait for the seedlings to emerge and record percentage emergence.

   c. Determine percentage establishment to ascertain plant stand per ha.

2. **Structured talk for learning:** Learners in their original groups discuss their experimental results and present them in the class. Teachers should assist groups having difficulties and encourage all learners to participate in all the group activities.

Key Assessments

Assessment Level 1: List four pre-plant activities that should be performed when growing arable crops.

Assessment Level 2: Explain why selecting an appropriate crop variety is important in arable crop production.

Assessment Level 3: Differentiate between a ridge and a mound and give two crops grown on each of them.

Assessment Level 4

1. A farmer recorded 87% seedling emergence from the certified maize seed purchased from the store. How much seed, in Kg, will the farmer lose if he plants 130kg of maize seeds on his farm?
2. In a tabular form, group the key activities needed to produce a selected arable crop like maize under either pre-planting, planting or post-planting activities.

Hint

The recommended mode of assessment for week 13 is checklist. Use the level 4 question 2 as a sample question.

Week 14

Learning Indicator: Produce at least one arable crop from cereals, legumes and tubers

Focal Area: 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

1. **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 harbo ur 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 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 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.*

2. **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 ana adequate soil moisture for optimal plant growth and yield.

3. **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 by means of mechanical fertiliser spreaders.

ii. **Banding**: This involves placing fertilisers in concentric bands near the crop or root zone. 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 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, as they play important roles in the plant and animal physiology. Examples are iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), molybdenum (Mo), boron (B) and chlorine (Cl).

4. **Thinning:** It is the practice of removing excess seedlings per crop stand to reduce intra-specific 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, resulting in increased productivity.

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

5. **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.

6. **Staking and support:** Supporting tall or climbing crops prevents lodging (falling over) and facilitates better growth. The benefits of staking include:

   a. **Improved light exposure:** Staking allows plants to grow vertically, ensuring 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 maximizes available space, allowing more plants per unit area.

   d. **Reduced pest damage:** Keeping plants, leaves and fruits off the ground minimizes 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

7. **Mulching** involves covering the soil around crops with various materials such as trash, straw, sawdust and compost. Below are some benefits of mulching

   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.

8. **Earthing up:** Also known as hilling, 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 and pest and disease management.

9. 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. Here are some common pests and diseases affecting arable crops, and their management strategies.

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.
Rootknot nematodes	Yam, sweet potato, carrot, cowpea, groundnut.	Severely galled roots that affect water and nutrient absorption.	Crop rotation

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

10. **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.

        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.

Learning Tasks

1. Learners to identify post-plant activities that are carried out for arable crops.
2. Learners to discuss the importance of post-planting activities of arable crops.
3. Learners to practise the correct use of pesticides to manage pests and diseases of arable crops.
4. Learners to experiment with fertilisers to see the effect on plant growth and yield and present reports.

Pedagogical Exemplars

1. **Collaborative learning:** Put learners in mixed-ability groups and guide them with probing questions to identify and discuss various post-plant cultural practices of arable crops. Teachers should encourage all learners to take part in the discussion.
2. **Project-based learning:** Learners practise pest management activities
    a. Estimate pest and disease infestation (number of plants infested/damaged/dead, type of pests seen per unit area).
    b. Determine the correct pesticide dosage (millilitres per liter)
    c. The teacher/technician demonstrates the correct application of pesticide
    d. Learners practise pesticide application

3. **Experiential learning:** The teacher guides learners to study the effect of fertilisers on crop growth and yield
    a. Learners demarcate two plots of the same size
    b. Grow the same crop on both plots
    c. One plot receives the recommended amount of fertiliser, the other none (control)
    d. Measure plant height, number of leaves/branches, stem girth, number of flowers/pods and yield per unit area, on both treatments.
    e. Learners compare yields across the two plots to determine the effect of the fertiliser.
4. **Talk for learning:** Learners in their original groups discuss their findings and experiences and present reports. Teachers should guide learners to write their reports using the standard procedure for presenting a scientific experimental report.

Key Assessments

Assessment Level 1: List five post-plant activities for arable crops.

Assessment Level 2: Explain the relevance of pruning and staking in arable crop production.

Assessment Level 3: Demonstrate skills in pesticide application in arable crop production. (NB. Field observation should be used to assess learners).

Assessment Level 4: Write a scientific report on the effects of fertilisers on plant growth and development based on the experiment performed.

Week 15

Learning Indicator: Carry out required post-harvest practices and market produce

Focal Area: Post-harvest practices and marketing of selected arable crop produce

1. **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

a. **Threshing:** Threshing involves separating the grain from the straw, chaff, or pod. It can be done manually or mechanically.

   i. **Manual threshing:** In legumes, manual threshing is achieved by beating the pods packed in jute sacs with sticks or trampling the pods on clean floors after sun drying.

   ii. **Mechanical threshing:** Using machines like threshers which are more efficient and less labour-intensive.

b. **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.

c. **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.

d. **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:

   i. **High market price:** Sorting and grading raises the value of the crops with consequent higher prices.

   ii. **Consumer satisfaction:** Sorting and grading ensures that consumers receive high-quality products.

   iii. **Compliance with standards:** Sorting and grading help meet local and international standards and regulations.

   iv. **Waste reduction:** Sorting and grading reduces waste by identifying and putting lower-grade produce to alternative uses.

e. **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.

f. **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.

g. **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.

   i. Benefits of processing arable crops

      - 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.

   ii. 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.

h. **Packaging:** Packaging refers to the materials and containers used to protect, store, transport and display products. The benefits of proper packaging include:

   - protection of produce from crushing, bruising and breaking during handling, transportation and storage.
   - preservation of produce quality and freshness.
   - protection against dust, dirt, chemicals and other contaminants.
   - prevention of mould growth and spoilage.
   - protection from microbe, insect and rodent attack.
   - extension of shelf life without significant loss in quality.
   - easier handling and transportation.
   - better eye appeal to consumers.
   - provides critical information about the product, including origin, nutritional content, and handling instructions.

i. 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.

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

      - Silos: Tall cylindrical structures used for storing large quantities of grains like maize, wheat, and barley. Silos protect grains from pests and moisture.
      - Warehouses: Large buildings used for storing bulk quantities of crops, providing protection from weather and pests.
      - Bins and bunkers: Smaller containers for temporary storage on farms or processing facilities.
      - Pits and piles: Open-air storage methods used for certain crops, but susceptible to weather and pest damage.
      - 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)*

2. **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.

   a. **Distribution channels:** Farmers can use the following market channels to market their produce successfully.

i. **Direct sales:** Selling directly to consumers or retailers through farmers' markets, farm stands, or community-supported agriculture (CSA) programmes.

ii. **Wholesale markets:** Selling to wholesalers who resell to retailers or food processors.

iii. **Contracts:** Establishing contracts with buyers for future delivery at an agreed price.

b. **Timing marketing of arable crops:** This can help farmers to increase their profit margins. This can be achieved by;

i. **Seasonal sales**: Timing sales to coincide with lean season or high-demand periods.

ii. **Storage and logistics**: Ensuring adequate storage facilities and efficient transportation to keep produce until "the price is right."

c. **Promotion and advertising:** Farmers can do the following to enhance the marketing of arable crop produce.

i. **Branding:** Developing a unique identity for the farm or product.

ii. **Advertising:** Using print, digital, and social media to reach potential buyers.

iii. **Promotions:** Offering discounts, samples, or special deals to attract customers

Learning Tasks

1. Learners to search for various post-harvest operations in arable crop production.
2. Learners to discuss the importance of post-harvest operations in arable crop production.
3. Learners to practise the post-harvest operations in arable crop production.
4. Learners to analyse strategies for marketing arable crops.

Pedagogical Exemplars

1. **Collaborative digital learning:** Learners in mixed-ability groups surf the Internet to identify and discuss the importance of post-harvest operations in arable crop production. Teachers should guide learners with leading questions and encourage teamwork among the learners
2. **Project-based learning:** The teacher leads learners to a farmer's field to do the following
   a. learn how to determine crop yield.
   b. practise the correct ways of harvesting, cleaning, sorting, grading and bagging selected crops.
   c. learn how to set the weight and volume of produce, using indigenous and standardised instruments.
3. **Talk for learning:** Learners in their original groups, discuss their findings from the field and present a report to the class. Teachers should assist all groups as necessary and ensure all learners participate fully in the discussions.

Key Assessments

Assessment Level 1: List five post-harvest operations in arable crop production.

Assessment Level 2: Explain two reasons for the importance of grading and packaging.

Assessment Level 3: Examine the economic importance of processing farm produce

Assessment Level 4:

1. Analyse three strategies for marketing farm produce to increase farmers' profit margins.
2. State and explain briefly the main post-harvest operations that should be caried out in arable crops production.

Hint

The recommended mode of assessment for week 15 is questioning. Use the level 4 question 2 as a sample question.

SECTION 5 REVIEW

The section introduced learners to arable crop production. Arable crop production involves market need analysis, pre-planting, planting and post-planting activities, harvesting and post-harvest operations. The section is to help learners appreciate and practise crop production for consumption and profit. Learners have to relate the crop chosen to soil type, climatic conditions, water availability, topography, market and road access. The crop, soil type and topography also determine the method of land preparation. Post-planting activities were discussed in detail to help learners appreciate the role of weed control, thinning, pruning, staking, irrigation, fertiliser application, earthing up, and pest and disease control, to ensure healthy growth and large yield. Post-harvest operations such as threshing, cleaning, drying, sorting and grading, processing, packaging and storage have been included in the section to help learners appreciate the role of value addition to the produce. The section and the chosen pedagogies are intended to improve crop production and business skills, and the values of accountability and fairness in the learners.

APPENDIX L: TABLE OF SPECIFICATION FOR THE END OF FIRST SEMESTER EXAMINATION

Hint

Cover content from weeks 1-12 learning outcomes taking DoK levels 1-4 into consideration

Weeks	Learning Indicator(s)	Type of Questions	DoK Levels				Total
			1	2	3	4	
1	1. The meaning and relevance of scientific experimental procedure in Agricultural Science. 2. Scientific experimental procedures in Agricultural Science	Multiple Choice	1	1	1	-	3
		Essay	-	1	-	-	1
		Practical	-	-	1	-	1
2	Measuring instruments used in agricultural production	Multiple Choice	1	2	1	-	4
3	Simple scientific measuring tools for assessing parameters in agricultural production.	Multiple Choice	1	1	1	-	3
		Practical	-	-	-	1	1
4	Safety in operating farm machines in agricultural production.	Multiple Choice	1	1	1	-	3
		Essay	-	-	-	1	1
5	First aid in agricultural production.	Multiple Choice	2	1	-	-	3
6	Describe the economic importance of selected arable crops (cereals, legumes, and tubers) in the livelihood of the producers and the broader value chain.	Multiple Choice	1	1	1	-	3
7	1. Discuss characteristics of successful startup packages of arable crop enterprises. 2. Catalogue the characteristics and patterns of growth of successful arable crop (cereals, legumes, and tuber crops) enterprise	Multiple Choice	1	1	1	-	3
		Practical	-	-	-	1	1
8	Explain the role of precision agriculture in arable crop enterprises.	Multiple Choice	2	1	-	-	3
		Essay	-	1	-	-	1
9	Describe the use and importance of mini-sett technique in seed yam production.	Multiple Choice	1	2	1	-	4
		Essay	-	1	-	-	1

10	Identify and classify different types of machinery used in arable crop (cereals, legumes and tubers) production.	Multiple Choice	1	1	1	–	3
		Essay	–	1	–	–	1
		Practical	–	–	1	–	1
11	Operate different types of machinery used in arable crop production	Multiple Choice	2	2	1	–	5
12	Identify market needs for arable crops (cereals, legumes, and tuber crops).	Multiple Choice	1	1	–	–	2
		Essay	–	–	1	–	1
		TOTAL	15	19	12	3	49
		%	30	40	30	100	

NB. Modify, complete and use this table to set your examination questions.

APPENDIX M: MARKING SCHEME FOR CHECKLIST AND QUESTIONING

1. **Checklist**

STAGE	ACTIVITIES	REMARKS	
		Yes	No
Pre-planting	Site selection		
	Soil testing		
	Selection of crop variety		
Planting	Land preparation, etc.		
	Seed treatment		
	Sowing of seeds		
	Transplanting, etc.		
Post-planting	Irrigation		
	Weed control		
	Pest and disease control		
	Fertilizer application, etc		

(1 mark for each correctly marched activity)

2. **Questioning**

   a. Threshing: involves separating the grain from the straw, chaff, or pod

   b. Cleaning: it involves winnowing, sieving and air screening to remove debris, dust and unwanted materials from the grains.

   c. Drying: is done to reduce the moisture content of the grains below 14% before storage, etc

1 mark for each correct statement

1 mark for each explanation with keywords and phrases

SECTION 6: PRODUCING ANIMALS FOR INCOME

Strand: Farming for jobs and incomes

Sub-Strand: Economic production of animals

Learning Outcome: Use the knowledge acquired to produce ruminants

Content Standard: *Demonstrate knowledge, skills and understanding of economic production of ruminants.*

Hint

- *Remind learners of Mid-semester examination in Week 18. Refer to the Appendix N for more sample task and the Table of Specification.*
- *Assign learners individual project in week 20 to be submitted in week 22. Refer to the Appendix O at the end of this section for more information on individual project.*

INTRODUCTION AND SECTION SUMMARY

The section aims to help learners acquire the prerequisite knowledge and skills to plan, organise, produce and market small ruminants. The section will help learners understand the principles and be able to rear the ruminants for sale and livelihood enhancement. Small ruminant production is an established part-time activity in many parts of Ghana, hence can be practised with greater attention when learners acquire better knowledge. The teacher and learners will find a link between the concepts in this section and related subjects such as economics and business studies. Learners will be exposed to pedagogical exemplars such as experiential learning, collaborative learning and project-based learning, and the teacher will be conscious of the religious and socio-cultural beliefs and taboos of the learners, during the experiential activities. Both formative and summative assessment techniques would be used to promote inclusiveness and cater for the differences in the ability of learners.

The weeks covered by the section are:

Week 16: Identify resources and market needs for small ruminants.

Week 17: Produce small ruminants (sheep or goats) common in the locality for meat.

Week 18: Outline various distribution outlets and ways of marketing meat and other products of small ruminants.

Week 19: Explain the methods for rearing snails.

Week 20: Explain the methods for rearing grasscutters.

SUMMARY OF PEDAGOGICAL EXEMPLARS

Teaching the concepts under this section requires a blend of pedagogical strategies that will stimulate discussion and promote teamwork among learners. Pedagogical exemplars like talk for learning, collaborative digital learning and experiential learning have been suggested. Project-based and experiential learning strategies, in particular, have been proposed to enable learners to understand and appreciate the rearing of ruminants. Teachers should consider the mixed ability and gender (where appropriate) groupings when using these pedagogical strategies to encourage inclusiveness and reduce stereotyping among learners. The teachers should consider differences in learners' ability when assigning tasks and assessment activities, to ensure all learners participate fully. Additional and more challenging tasks should be assigned to the highly proficient learners and encouraged to help other learners.

ASSESSMENT SUMMARY

Assessment strategies that promote inclusiveness and consider differences in learners' abilities should be deployed. This should help to motivate them to participate fully and contribute meaningfully to learning new concepts. Both formative and summative assessment techniques have been indicated in this section. While the former should be used during the teaching process to check learners' progress, the latter should be used at the end of the section to measure learners' achievements. Teachers should use individual responses to oral questions during the talk for learning and experiential learning as an assessment tool to encourage learners, as it helps them to develop and enhance communication skills. Written responses to questions or tasks should be encouraged to improve their critical thinking and writing skills. Teachers are expected to give prompt feedback on learners' performance and update the transcript system with learners' assessment records.

Week 16

Learning Indicator: Identify resources and market needs for small ruminants

Focal Area 1: Resources and market needs for producing ruminants

Resource market needs for producing ruminants

Ruminants are herbivorous grazing or browsing animals that can acquire nutrients from plant materials through microbial fermentation in a specialized 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.

1. **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

a. Pasture land: Ruminants require adequate fenced grazing land or pasture.

b. Financial capital: Some capital is needed to establish the ruminant farm. Detailed financial planning and budgeting are required before making any investments.

c. 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.

d. Breed selection and acquisition: Acquire suitable breeds for the area and farming objectives, from reputable breeders or markets.

e. 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.

f. 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.

g. Crossing and breeding: Select animals with desirable genetic traits for crossing to produce healthy and vigorous offspring.

h. Regulatory and legal requirements: Farmers must comply with local regulations and permits related to farming operations, animal health and the environment.

i. 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.

2. **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

   a. **Market analysis**

      - Consumer demand: Consumer preferences for lamb 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.
      - Economic factors: Analyse the economic environment – income levels and purchasing power – on meat and dairy consumption.

   b. **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.

   c. **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.

   d. **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.

   e. **Technological advancements:** The role of technology in improving production efficiencies, such as advancements in animal health, feed and genetic improvements should be considered.

   f. **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.

g. **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.

h. **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.

Learning Tasks

1. Identify frequently patronised small ruminant products in homes and food joints.
2. Examine the resources needed for ruminant production and sale.
3. Analyse the market needs for ruminant production.
4. Explain how knowledge of resources and market needs enhances the production of small ruminants.

Pedagogical Exemplars

1. **Talk for learning:** The teacher guides learners in mixed groups to identify and list frequently patronised small ruminant products in their homes and food joints. The teacher uses questions to help learners differentiate ruminants from other farm animals.
2. **Project-based learning**
   a. Learners, in mixed groups, visit the community market/cold store, with a checklist to collect information on the small ruminant products which are most popular.
   b. Learners in the same groups, visit ruminant farms or watch videos on the sale of produce and products and record activities.
   c. The teacher should be mindful of the socio-cultural and religious differences of the learners as they handle the animals and meat products.
3. **Collaborative learning:** Learners in their groups discuss the resources and market needs to start the production of small ruminants. Learners paste their findings written on cardboard on the classroom walls for other groups to read. All learners should be encouraged to participate in all activities.

Key Assessments

Assessment Level 1: State four market needs that influence the production of small ruminants.

Assessment Level 2: Mention two resources and indicate how they affect a small ruminant farm establishment.

Assessment Level 3: Explain two ways the knowledge of resource and market needs enhances the production of small ruminants.

Assessment Level 4

1. Outline how consumer behaviour can affect the sale of chevon.
2. Conduct research on identification of resources and market needs for ruminant production and write report 300 words long.

Hint

*The recommended mode of assessment for week 16 is **research**. Use the level 4 question 2 as a sample question.*

Week 17

Learning Indicator: Produce small ruminants (sheep or goats) common in the locality for meat

Focal Area 1: 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 in various ways 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.

   a. Advantages of extensive system of keeping small ruminants

   i. Suitable for small-scale farmers and those with limited resources.

   ii. Efficient use of lands unsuitable for crop production.

   iii. Promotes ecological balance by utilising natural vegetation and maintaining soil fertility through manure.

   iv. The animals exhibit natural behaviours, leading to improved health and well-being.

   v. Lower feed and housing costs as animals graze on natural pastures.

   vi. Reduced labour cost.

   vii. Lower disease incidence due to reduced animal density and natural grazing behaviours.

   viii. Reduced medication and treatment costs.

   b. Disadvantages of extensive system of keeping small ruminants

   i. Small ruminants are vulnerable to predators such as wolves, coyotes and dogs.

   ii. Requires significant effort for herding, predator control, and health monitoring over the large area.

   iii. Overgrazing can happen, leading to soil erosion, loss of vegetation, and land degradation.

   iv. Grazing areas might not always provide a balanced diet, leading to deficiencies or malnutrition, especially in seasons with poor forage quality.

   v. The animals are more exposed to harsh weather conditions that affect their health and productivity. Providing shelter in large areas is impractical.

vi. Access to clean, reliable water sources is a challenge, especially in arid or semi-arid regions.

vii. 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.

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

   a. **Advantages of semi-intensive system of keeping small ruminants**

      i. 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.

      ii. The animals are better monitored than in extensive systems, allowing for early detection and treatment of diseases.

      iii. Animals exhibit natural behaviours by grazing in open spaces, which improves their overall welfare and reduces stress compared to intensive confinement.

      iv. They reduce overgrazing and soil erosion, promoting better land management and environmental sustainability.

      v. 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.

      vi. They are generally less labour-intensive than fully intensive systems, as animals can graze and move freely within designated areas.

      vii. Properly managed semi-intensive systems can help minimise the environmental impact of farming by balancing grazing pressure and reducing the need for chemical inputs.

   b. **Disadvantages of semi-intensive system of keeping small ruminants**

      i. 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.

      ii. Balancing the needs of grazing with supplemental feeding and health care requires careful planning and management, which can be complex and time-consuming.

      iii. If not managed properly, semi-intensive systems can lead to localized overgrazing, soil compaction, and nutrient runoff, negatively impacting the environment.

      iv. 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.

      v. Maintaining fences, water systems and shelters requires ongoing investment and labour that can be costly.

vi. 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.

vii. 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.

a. Advantages of the intensive system of keeping small ruminants

i. The animals receive a carefully balanced diet tailored to their needs, leading to better growth rates, milk production and overall health.

ii. Maintains a healthier flock, as it is easier to detect diseases early, and administer vaccinations or treatments promptly.

iii. Intensive systems often use modern technology and practices to optimise feed, water and other resources, resulting in higher productivity per input unit.

iv. Higher meat, milk, and wool production due to better nutrition, health management and breeding practices.

v. Although intensive systems require more daily labour, the tasks are often more predictable and manageable. Automation and mechanisation can further enhance labour efficiency.

vi. The system allows for better control of the animals' environment, protecting them from harsh weather and reducing predation.

vii. 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.

viii. Intensive systems can produce animals with more consistent size, weight and health.

ix. Intensive systems provide opportunities for training, research and advanced husbandry techniques, contributing to the advancement of small ruminant farming practices.

b. Disadvantages of the intensive system of keeping small ruminants

i. Intensive systems require a significant upfront investment in infrastructure, equipment and technology, which can be a barrier for small-scale or resource-limited farmers.

ii. Feed, veterinary care, labour and maintenance costs are higher in intensive systems compared to extensive systems.

iii. The close confinement of animals increases the risk of disease transmission. Outbreaks can spread rapidly, leading to significant losses.

iv. Intensive systems can generate large amounts of waste, which, if not managed properly, can lead to environmental pollution, including water contamination and soil degradation.

v. Intensive systems typically consume more energy for heating, cooling, lighting and operating equipment, contributing to higher greenhouse gas emissions.

vi. The high density of animals can lead to stress, aggression and a higher incidence of injuries and diseases, raising animal welfare concerns.

vii. 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.

viii. Managing an intensive system requires skilled labour for tasks like feeding, health monitoring and breeding management, which can be costly and difficult to source.

ix. In-breeding reduces resilience, making the population more susceptible to diseases and environmental stresses.

x. Intensive systems often rely on advanced technology and mechanisation, which require regular maintenance and can be expensive to repair or replace.

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. New-born 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 transitioning 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 nematode 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

Different species of lice on small ruminants

Developmental stages of a tick species

Figure.17.1 Blow fly adult and larvae (maggots)

Examples of endoparasites of small ruminants

Tapeworm

Roundworms

Learning Tasks

1. Learners to identify the management systems for keeping small ruminants in Ghana.
2. Learners to explain the benefits of using the management systems to produce small ruminants for meat effectively
3. Learners to explain how breeding stock selection and health management affect the production of small ruminants.
4. Learners to identify and analyse factors influencing the production of small ruminants for meat.

Pedagogical Exemplars

1. **Talk for learning:** Learners brainstorm in mixed groups to distinguish between the management systems for keeping small ruminants. Teachers should encourage learners to tabulate the advantages of using the systems.
2. **Experiential learning**
   a. The teacher takes learners to visit an established small ruminant farm to gather information on building a pen, feed and water rations and sources of vaccines.
   b. Learners should also gather information on how to select the breeding stock, care for pregnant and young animals and manage pests and diseases. The learners should be encouraged to record the data in their field notebooks.
   c. Learners should discuss the information collected from the farm when back in the classroom.
   d. The teacher should ensure that all learners participate in the collection of data and the discussion. All learners should be encouraged to participate in the groups. The teacher should be mindful of the religious beliefs and taboos of learners about the ruminants.

3. **Collaborative learning:** The teacher guides learners in mixed groups to map out the plan for taking care of the pregnant animals before and after birth. Learners in their groups should discuss ways of maintaining the young animals. Learners should be encouraged to think critically and apply the knowledge acquired from the farm during classroom discussions.

Key Assessments

Assessment Level 1: List three systems of keeping small ruminants for meat.

Assessment Level 2: Discuss two advantages and disadvantages of each system of keeping small ruminants.

Assessment Level 3: Explain the benefits of breed selection and health management to the production of small ruminants for meat.

Assessment Level 4

1. Analyse two factors influencing the production of small ruminants for meat.
2. The table below shows a comparison of extensive, semi-intensive, and intensive systems for keeping small ruminants, copy and complete it. (0.5 mark for each space correctly filled)

S/N	Aspect	Rearing system		
		Extensive	Semi-intensive	Intensive
1	Input costs	Low	Moderate	High
2	Animal welfare	High, natural behaviours encouraged	...	...
3	Labour requirements	....	...	High
4	Predation risk	High	...	....
5	Disease and parasite exposure	...	....	Low
6	Land use	....	Requires moderate quality land	...
7	Feed dependency	Low, relies on natural forage	...	...
8	Environmental Impact	...	Moderate, balanced approach	...
9	Weather dependency	...	...	Low, animals housed in controlled environments
10	Productivity (growth & milk)	Low	...	...
11	Management challenges	...	...	Low, easy monitoring and control

Hint

*The recommended mode of assessment for week 17 is **quiz**. Use the level 4 question 2 as a sample question.*

Week 18

Learning Indicator: Outline various distribution outlets and ways of marketing meat and other products of small ruminants

Focal Area 1: 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 the meat and other products. The producers and marketers can effectively promote and sell ruminant products, build strong relationships with consumers, and ensure business growth, by focusing on these strategies.

1. **Examples of ruminant products**
    a. Dairy: Milk, cheese/"wagashi," yogurt, butter and cream.
    b. Meat: Chevon (goat) and mutton (sheep).
    c. By-products: Hide, leather, wool, manure, the bones for feed and fertiliser and tallow (obtained by rendering or melting down the fat tissue) for cooking, making soap, candles, lubricants and biodiesel.
2. **Steps in marketing produce and products**
    a. **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 the sales point. An unhygienic abattoir is a major concern of many consumers.

    b. **Understanding the market**
        i. 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.
        ii. Target consumers: Define the target consumers based on their buying behaviour.
    c. **Product advertising**
        i. 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.
        ii. 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.
        iii. Value-added products: Products like cheese, yogurt and leather goods should be provided.

d. **Marketing channels**

i. 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.

ii. Retail and wholesale local retailers: Farmers can partner with local grocery stores, specialty food stores and co-operatives to reach more consumers.

iii. Food services and wholesale: Products can also be supplied to restaurants, hotels, larger retailers and institutions.

iv. Digital marketing

- Website: A user-friendly website with detailed product information, recipes, and farm stories can be created ensuring that it is optimised for search engines.
- Social media: Any social media platform can be used to engage consumers, share behind-the-scenes content, and promote/showcase products.
- Email marketing: Farmers should build an email list of consumers and send regular newsletters with updates, promotions, recipes and educational content.

e. **Content marketing**

i. Educational content: Blog posts, videos, and infographics that educate consumers about the benefits of ruminant products, sustainable farming practices and recipes should be created.

ii. 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.

f. **Promotion and advertising**

i. Local advertising: Farmers can engage local newspapers, radio, community bulletin boards and information centres to reach nearby consumers.

ii. 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.

iii. 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.

g. **Quality assurance**

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

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

h. **Distribution and logistics**

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

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

i. **Customer service**

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

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

j. **Ethics and sustainability practices**

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

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

Learning Tasks

1. Learners to identify ruminant products.
2. Learners to identify and explain steps in ruminant product marketing.
3. Learners evaluate the importance of using these steps to market the produce and products of ruminants.

Pedagogical Exemplars

1. **Think pair share:** Learners in pairs brainstorm the various products obtained from small ruminants. They should be helped to record their answers in their notebooks. They then share their findings with their peers.
2. **Collaborative learning:** Learners in mixed groups discuss the various distribution outlets in the community and ways of marketing the ruminants produced. The teacher should ensure that all learners participate in the activities and discourage a few learners from dominating the activity. Confident learners should be encouraged to support other learners and take on more demanding tasks.
3. **Role play:** The teacher encourages learners to take on roles to demonstrate the marketing of ruminant products to ensure that the concepts are applied. Some learners will play wholesalers, retailers, online sellers, and advertisers. This will allow them to consider responsive communication, customer feedback, ethics and sustainable practices, such as eco-friendly practices and animal welfare. More confident learners with identified talents should be encouraged to take up the roles and shyer learners should also be given roles. Learners' cultural and religious backgrounds should be considered when assigning the roles.

Key Assessments

Assessment Level 1: List five ruminant products, indicating the animal from which they are obtained.

Assessment Level 2: Explain any four steps in marketing ruminant produce and products.

Assessment Level 4: How will ethics and customer engagement improve the sale of ruminant products?

Hint

*The recommended mode of assessment for week 18 is **Mid semester examination**. Refer to the Appendix N for more sample task and the Table of Specification.*

Week 19

Learning Indicator: Explain the methods for rearing snails

Focal Area 1: 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:

1. **Key components of snail farming**

   a. **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 from 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 19.1: *Achatina achatina. Source: Wikipedia*

Figure 19.2: *Archachatina marginata. Source: https://insektenliebe.com/en/*

Figure 19.3: *Achatina fulica. Source: Wikimedia Commons*

   b. **Farm setup**

      i. 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.

      ii. 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:

- Box or cage system: Snails are raised in boxes or cages made from wood, plastic, used car tyres, or metal mesh.
- Pen system: Snails are kept in outdoor pens made of wood, metal, concrete, or plastic, with a mesh or netting cover to prevent escape.
- 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.

- Indoor system: Snails are raised indoors where temperature, humidity and lighting can b e 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 19.4: *Box pen*

Figure 19.4: *Large-scale concrete pen*

c. **Key considerations for all methods**

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

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

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

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

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

vi. Protect the snails from direct sunlight and predators.

d. **Breeding and reproduction**

i. 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.

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

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

iv. 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.

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

i. Nutritional requirements

- Calcium: Essential for shell development. Sources include crushed eggshells and limestone powder.
- Protein: Needed for growth and reproduction. Protein-rich foods include legumes, fish meal and leafy vegetables.
- Carbohydrates: Tubers, fruits and vegetables provide energy.
- Vitamins and minerals: Maintain overall health. A balanced diet with a variety of foods usually covers these needs.

ii. Types of feed

- Green vegetables: Fresh cocoyam leaves, lettuce, cabbage, spinach and other leafy greens are excellent choices.
- Fruits: Bananas, melons and pawpaw. Avoid citrus fruits as they can be too acidic.
- Tubers: Cassava, yams and sweet potatoes.
- Supplementary feeds: Commercial snail feed; specially formulated to ensure a balanced diet.

iii. Feeding practices

- Quantity: Snails should be fed based on size and population density. Overfeeding can lead to waste, while underfeeding can stunt growth and affect reproduction.
- Frequency: Feed snails once or twice a day. Evening feeding is recommended since snails are more active at night.
- Hygiene: Remove any uneaten food daily to prevent mould and pests. Clean feeding areas regularly.
- 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 water and place them in the pen.

f. **Health and hygiene management**

i. Pests

- Rats and Mice: These rodents are major predators of snails. They can cause substantial damage by eating the snails and their eggs.
- Birds: Some birds like the crow prey on snails, particularly during the early morning.
- Frogs and toads: Amphibians like frogs and toads can consume juvenile snails.
- Ants: Certain ant species, for example, driver ants, invade snail pens, feeding on eggs, juveniles and even adult snails.
- Mites: Mites can parasitise snails, causing irritation and possible infections.

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

ii. Diseases

- Bacterial Infections
- *Pseudomonas* spp.: Can cause shell disease and lesions on the snail's body.
- *Aeromonas hydrophila*: Known to cause infections leading to tissue damage and eventual death.
- Fungal Infections
- *Fusarium* spp: Causes soft shell and foot rot, leading to the weakening of the snail's shell and body.
- *Penicillium* spp.: Another fungus that can cause shell deterioration.
- Protozoan Infections: Ciliates and Amoebae: These single-celled organisms can cause digestive and other health problems in snails.

iii. Pest control measures

- Quarantine: Isolating new snails before introducing them to the main population can help prevent the spread of diseases.
- 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.

g. **Harvesting and cleaning**

i. 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.

ii. 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.

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

h. **Marketing and sales**

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

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

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

Learning Tasks

1. Learners to list various processes and activities involved in snail rearing.
2. Learners discuss the processes and activities involved in snail rearing.
3. Learners to undertake a snail-rearing project in their schools.

Pedagogical Exemplars

1. **Talk for learning:** Learners in small groups identify the processes and activities involved in snail farming and present their findings. Teachers should appoint group leaders to keep the group on task, focused on the objective, and lead the group discussion. Teachers should support groups with difficulty with leading questions, and encourage all learners to be part of the discussion.
2. **Digital learning:** Learners in mixed ability and gender groups watch video documentaries on snail farming, discuss their observations and report their findings. Guide learners with leading questions to enable them to focus on the activities involved in snail farming as they watch video documentaries.
3. **Project-based learning:** The teacher guides learners to establish a snail farm in the school.
    - Create a snail housing using old car tyres, metal drums, large plastic containers, wood, or concrete tanks.
    - Prepare substrate or bedding material (Coconut coir, peat moss, or sawdust, mixed with black soil).
    - Acquire snail stock from a certified source.
    - Provide suitable feed daily.
    - Moisten the environment with clean fresh water regularly.
    - Monitor and manage pests and diseases.

Key Assessments

Assessment Level 1: List five snail rearing activities.

Assessment Level 2: Explain breeding in snail farming.

Assessment Level 3: Assess the suitability of different pen types for rearing snails.

Assessment Level 4: Evaluate the effectiveness of measures to protect snails from pests.

Focal Area 2: Benefits of snail rearing

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

1. **Financial benefits**
    a. **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.

b. **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.

c. **Quick reproduction cycle:** Snails reproduce quickly and in large numbers, allowing farmers to scale their operations and increase production quickly.

d. **High profit margins:** Due to their delicacy status and various applications, snails can be sold at premium prices in local and international markets.

e. **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.

f. **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.

g. **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.

2. **Health benefits**

a. **Good protein source:** Snail meat is an excellent source of protein and essential amino acids, for muscle repair, growth and overall body function.

b. **Low in fat:** Snail meat has low-fat content, making it a healthier alternative to many traditional protein sources.

c. **Vitamins:** Snail meat is a good source of vitamin B12. This vitamin is important for nerve function, DNA production and red blood cell formation.

d. **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.

e. **Low caloric content:** The low-calorie content of snail meat makes it an ideal food for those managing their weight.

f. **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-aging skincare products.

g. **Omega-3 fatty acids:** Snail meat contains Omega-3 fatty acids, which promote heart health by lowering blood pressure and preventing heart disease.

h. **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.

i. **Digestive health:** The chitin in snail meat acts as dietary fibre, promoting healthy digestion and preventing constipation.

3. **Social benefits**

    a. **Job creation and employment:** Snail farming can create jobs in rural and urban areas, providing employment for locals and reducing unemployment rates.

    b. **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.

    c. **Economic growth:** The increased economic activity from snail farming can stimulate local economies, encouraging further development and investment in the area.

    d. **Social inclusion:** Snail farming is accessible to women, youth and the elderly, promoting inclusivity and diversity in agriculture.

    e. **Social empowerment:** Marginalised groups get opportunities to generate income and improve their social standing.

    f. **Cultural significance:** In many cultures, snail consumption is a traditional practice and promoting snail farming can help preserve and celebrate cultural heritage.

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

Learning Tasks

1. Learners to surf the Internet to identify the financial, health and social benefits of snail rearing.
2. Learners to discuss the benefits of snail farming.
3. Learners to compare the benefits of snail farming to traditional animal production.

Pedagogical Exemplars

1. **Digital learning:** Learners, in small groups, surf the Internet and other sources to compile the benefits of snail rearing, discuss their findings and present reports to the class. Teachers should lead learners with questions to enable them to list the benefits.
2. **Collaborative learning:** Learners, discuss the benefits of rearing snails and traditional animal production in their original groups, and present their findings in a plenary. Encourage more confident learners to lead and design the prompts to guide the discussion.

Key Assessments

Assessment Level 1: List five financial benefits of snail rearing.

Assessment Level 3: Explain four health benefits of snail meat.

Assessment Level 4

1. Compare the benefits of snail rearing to traditional farm animal production to the local community.

2. Your uncle established a snail farm two years ago and used to produce tonnes of snails. The production has decreased possibly due to poor health, as a SHS agricultural science student, explain how you can manage the health and hygiene of the snails in the farm to boost his production.

Hint

The recommended mode of assessment for week 19 is case study. Use the level 4 question 2 as *a sample question.*

Week 20

Learning Indicator: Explain the methods for rearing grasscutters

Focal Area 1: 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 20.1: *Grasscutter (Source: Agri4Africa)*

Figure 20.2: *Rat (Source: Brittanica)*

1. **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 include:

a. Wire mesh cages: These are simple and affordable.

b. Metal cages: These are wire mesh structures secured with metal frames.

c. Wooden cages: These are wire mesh structures secured with wood frames.

d. Concrete pens: They are made of a concrete base but covered with wire mesh. These cages are durable and easy to clean.

e. Breeding pens: Specialised cages for breeding and raising young grasscutters.

2. **Management and construction of grasscutter houses**

a. 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 m² per adult animal is recommended.

b. **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.

c. **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.

d. **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.

e. **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.

f. **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.

3. **Grasscutter breeding**

a. **Selection of breeding stock:** The breeding stock can be procured from certified breeding farms or selected from other farmers using the following criteria:

   i. Age: Select animals that are at least 6-8 months old to ensure they are mature enough for breeding.

   ii. Health: Choose animals that are healthy, free from disease and have no physical deformities.

   iii. Temperament: Choose animals with a calm and docile temperament, as they are easier to handle.

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

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

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

b. **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.

c. **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.

d. **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.

4. **Feeding guidelines**

   a. **Nutrient requirements:** Grasscutters require a fibre high 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.

   b. **Feed composition**

      i. 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.

      ii. 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.

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

   c. **Feeding practices**

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

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

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

5. **Pests of grasscutters**

   a. **External parasites**

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

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

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

   b. **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.

6. **Diseases of grasscutters**

   a. **Bacterial diseases**

      i. Salmonellosis: Caused by *Salmonella* bacteria, this disease can lead to diarrhoea, dehydration and death. Maintaining good hygiene and proper food handling can prevent outbreaks.

      ii. Pasteurellosis: Caused by *Pasteurella* bacteria. This disease can cause respiratory disease. Antibiotic treatment and good ventilation can control the disease.

b. Viral diseases

i. Rabies: Grasscutters can contract rabies through bites from infected animals. Vaccination and restriction of wild grasscutter populations can prevent this disease.

ii. Arenavirus infection: This virus can cause haemorrhagic fever in grasscutters. Preventive measures include restricting wild rodent populations and maintaining good hygiene.

c. Fungal diseases

i. Ringworm: This fungal infection causes circular, itchy lesions on the skin. Treatment involves antifungal medications and maintaining proper sanitation.

ii. Aspergillosis: Caused by *Aspergillus* fungi, whose spores cause respiratory disease. Ensuring good ventilation and using antifungal treatments can help manage infections.

d. Nutritional diseases

i. 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.

ii. 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

7. **Record keeping**

a. Breeding records: Keep detailed records of breeding activities, including mating dates, birth dates and litter sizes.

b. Health records: Maintain records of vaccinations, treatments and any health issues observed.

c. Feeding records: Document feeding schedules and any changes in diet.

Breeding Record Template

Date	Male ID	Female ID	Mating Date	Expected Birth Date	Actual Birth Date	Litter Size	Remarks
10-01-2024	M001	F001	10-01-2024	10-06-2024	12-06-2024	6	Successful, healthy litter

Health Record Template

Date	Grasscutter ID	Health Check	Symptoms Observed	Vaccinations/ Treatments	Medication Given	Follow-Up Date	Remarks
15-01-2024	G001	Good	Slight limp in right leg	Rabies Vaccine	Anti-inflammatory	22-01-2024	Monitor limp

Feeding Record Template

Date	Grasscutter ID	Type of Feed	Quantity	Supplementary Feed	Water Provided	Remarks
10-01-2024	G001	Fresh Grass	1 kg	Corn	500 ml	Eating well
10-01-2024	G002	Cassava Peels	0.8 kg	Commercial Pellets		

8. **Handling grasscutters**

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

a. Handling techniques

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

ii. Securing the animal

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

b. Safety tips

i. 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.

ii. 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.

c. 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.

d. Social interaction: Grasscutters are social animals. Keeping them in groups can promote natural behaviours and reduce stress.

9. **Marketing and sales**

a. **Market research:** Identify potential markets for grasscutter meat and products. Understand consumer preferences and demand.

b. **Sales channels:** Explore various sales channels, including local markets, restaurants and direct sales to consumers.

Learning Tasks

1. Learners to a make list of various processes involved in grasscutter farming.
2. Learners to discuss the processes and activities involved in grasscutter farming.
3. Learners to undertake grasscutter farming project in the school.

Pedagogical Exemplars

1. **Collaborative learning:** Learners in groups, surf the Internet for processes involved in grasscutter farming and discuss their findings. Teachers should guide learners with leading questions to assist learners in difficulty and also encourage gifted learners to lead the groups.
2. **Digital learning:** Learners in mixed ability and gender groups (where appropriate) watch video documentaries on grasscutter farming, discuss their observations and present their findings to the class. More confident learners should be encouraged to report findings in a PowerPoint presentation.
3. **Project-based learning:** The teacher guides learners to establish a grasscutter farm/pen in the school.
    - The teacher together with learners create grasscutter housing where practicable. If not possible, the teacher takes learners to visit established grasscutter farms.
    - Where practicable learners establish cages and hutches and provide bedding materials such as straw or shredded paper.
    - Acquire the grasscutter breeding stock.
    - Provide daily suitable feed and clean fresh water.
    - Monitor and manage pests and diseases.
    - Where practicable, learners determine growth rate by measuring changes in weight with time.

Key Assessments

Assessment Level 1: List five processes involved in grasscutter farming.

Assessment Level 2: Explain three activities in grasscutter farming.

Assessment Level 3: Discuss breeding in grasscutter farming.

Assessment Level 4: Design a record keeping template on breeding, feeding and health for managing a grasscutter farm.

Focal Area 2: 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:

1. **Financial benefits**
    a. **High market price:** Grasscutter meat is a delicacy in many parts of Africa and commands a high market price.

b. **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.

c. **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.

d. **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.

e. **Job creation:** Grasscutter farming can create full time and part time employment for workers, unemployed and retired people.

f. **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.

g. **Low veterinary costs:** 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.

h. **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 ready to reproduce.

2. **Social benefits**

a. **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.

b. **Reduction in rural-urban migration:** Engaging the rural youth in grasscutter farming can reduce rural-urban migration.

c. **Rural poverty reduction:** Grasscutter rearing supports rural development by providing livelihoods and reducing poverty.

d. **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.

e. **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.

f. **Rural development:** Grasscutter farming can stimulate rural economies by creating new business opportunities and increasing household incomes, contributing to rural development.

g. **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.

3. **Health benefits**

   a. **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.

   b. **Low-fat content:** Grasscutter meat is lean, with lower fat content than other types of meat like pork and beef, hence recommended for healthy heart and weight management.

   c. **Reduced zoonotic disease risk:** Controlled farming environments lower the risk of disease transmission between animals and humans.

   d. **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.

   e. **Wild game conservation:** Domesticated grasscutter farming reduces the need for wild hunting, hence preserving wild game.

Learning Tasks

1. Learners to discuss the financial, social and health benefits of grasscutter farming.
2. Learners to compare the benefits of grasscutter farming to ruminant production.
3. Learners discuss grasscutters in food security.

Pedagogical Exemplars

1. **Digital learning:** Learners, in small groups, surf the Internet and other sources for the benefits of grasscutter rearing, discuss their findings and present reports. Teachers should assign leaders to the groups to be in charge of keeping the group on task and focused on the objective and present the group's work to the class. Teachers should support groups in difficulty with leading questions and encourage all learners to take active part in the discussion.
2. **Talk for learning:** Learners in the same groups, compare the benefits of grasscutter rearing to ruminant production concerning space requirements, cost of feeding, disease management and meat quality and present their reports to the class. Teachers can limit the groups to work on the areas mentioned above but the more progressive groups should be encouraged to go beyond their tasks,
3. **Collaborative learning:** Learners in mixed-ability groups discuss how grasscutter rearing can ensure food security and write group reports on their discussion.

Key Assessments

Assessment Level 1: State four financial benefits of grasscutter farming,

Assessment Level 2: Explain three social benefits of grasscutter farming.

Assessment Level 3: Examine three reasons grasscutter farming is more beneficial than ruminant production.

Assessment Level 4

1. Discuss the role of grasscutter rearing in food security.
2. Conduct research on grasscutter production in Ghana and write a report on your findings.

Hint

*The recommended mode of assessment for week 20 is **individual project**. Use the level 4 question 2 as a sample question. Refer to the Appendix O at the end of this section for more information on individual project.*

Section 6 Review

This section exposed learners to the requisite knowledge and skills for producing and marketing small ruminants. Experiential, collaborative digital and project-based learning were the pedagogies employed to promote inclusiveness and cater for the differences in the learners' abilities. Formative and summative assessment techniques were used to measure the level of the learner's understanding. The assessment tools were written responses to questions and oral presentations. At the end of the section, learners should be able to explain the process of raising small ruminants and rear them, at least, on a small scale, to be self-employable. Some learners can then collaborate and cooperate to start an animal production enterprise.

APPENDIX P: MARKING SCHEME FOR INDIVIDUAL PROJECT, CASE STUDY, QUIZ AND RESEARCH

1. MARKING SCHEME FOR THE INDIVIDUAL PROJECT ASSESSMENT TASK

Research report should consist of the following

Introduction: A brief introduction to the research background, like 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, etc. (2 marks)

Appropriate content: The learners› ability to demonstrate creativity and innovations in the research report, their understanding of the course content and to develop the skills being taught like practical skills.

This should include all main procedures and activities in grasscutter rearing

i. Housing infrastructure

ii. Grasscutter breeding

iii. Feeding requirements

iv. Pests and diseases of grasscutters

v. Record keeping

vi. Marketing and sales, etc.

(2 marks for each heading well crafted, 5 headings maximum)

Presentation: The research work should be well written and organized. Learners should be able to communicate their findings clearly and concisely, etc (2 marks)

2. MARKING SCHEME FOR THE CASE STUDY ASSESSMENT TASK

The reduction in production output due to poor health can be manage by the following

a. Proper farm hygiene through regular or daily cleaning of the environment by removing leftover feeds and all unwanted substances, etc. (Ability to clearly state, 2 marks)

b. Regular control of pests like rats, mice, frogs, ants, etc. (Ability to clearly state with examples, 2 marks)

c. Efficient control of diseases due to (bacterial, fungal and protozoan) infections like Pseudomonas spp, Fusarium spp and Ciliates etc. (Ability to clearly state with examples, 2 marks)

d. Quarantine ill or new snails: Isolating new snails before introducing them to the main population can help prevent the spread of diseases, etc. (2 marks)

e. Feeding: Clearly stating the following feeding practices

   i. Quality: Snails should be fed based on size and population density

   ii. Frequency: Feed snails once or twice a day. Feeding in the evening is recommended since snails are more active at night (3 marks for feeding)

f. Provision of water: Provide clean, fresh water daily for their digestive process. (1 mark)

Total – 20 marks

3. MARKING SCHEME FOR THE QUIZ ASSESSMENT TASK

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	Utilizes 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. RUBRICS FOR THE RESEARCH ASSESSMENT TASK

Criteria	EXCELLENT (4 MARKS)	VERY GOOD (3 MARKS)	GOOD (2 MARKS)	NEED IMPROVEMENT
Introduction	All 4 points for 4 marks i. **Key Resources** Identifies essential resources such as pastureland, financial capital, housing/shelter, and water supply. ii. **Market Context** Highlights the demand for ruminant products (meat, milk, wool) in local or global markets. iii. **Purpose** Explains the significance of understanding resource identification and market needs for establishing a successful small ruminant farm. iv. **Relevance** Connects the research to sustainable agriculture and rural development.	Any 3 points for 3 marks i. **Key Resources** Identifies essential resources such as pastureland, financial capital, housing/shelter, and water supply. ii. **Market Context** Highlights the demand for ruminant products (meat, milk, wool) in local or global markets. iii. **Purpose** Explains the significance of understanding resource identification and market needs for establishing a successful small ruminant farm. iv. **Relevance** Connects the research to sustainable agriculture and rural development.	Any 2 points for 2 marks i. **Key Resources** Identifies essential resources such as pastureland, financial capital, housing/shelter, and water supply. ii. **Market Context** Highlights the demand for ruminant products (meat, milk, wool) in local or global markets. iii. **Purpose** Explains the significance of understanding resource identification and market needs for establishing a successful small ruminant farm. iv. **Relevance** Connects the research to sustainable agriculture and rural development.	Any 1 point for 1 mark i. **Key Resources:** Identifies essential resources such as pastureland, financial capital, housing/shelter, and water supply. ii. **Market Context:** Highlights the demand for ruminant products (meat, milk, wool) in local or global markets. iii. **Purpose:** Explains the significance of understanding resource identification and market needs for establishing a successful small ruminant farm. iv. **Relevance:** Connects the research to sustainable agriculture and rural development.

Content	Any 4 points for 6 marks i. **Pastureland** Describes the importance of adequate grazing land and forage crops for feeding ruminants. ii. **Housing/Shelter** Details on how to design suitable housing to protect animals from weather and predators. iii. **Financial Capital** Explains sources of funding or investment required for starting and sustaining the farm. iv. **Breeding Stock** Highlights the need for selecting high-quality breeding stock for better productivity. v. **Healthcare** Emphasizes the role of veterinary care, vaccines, and disease prevention. vi. **Water Supply** Explains the need for a reliable and clean water source for drinking and cleaning purposes.	Any 3 points for 4.5 marks i. **Pastureland** Describes the importance of adequate grazing land and forage crops for feeding ruminants. ii. **Housing/Shelter** Details on how to design suitable housing to protect animals from weather and predators. iii. **Financial Capital** Explains sources of funding or investment required for starting and sustaining the farm. iv. **Breeding Stock** Highlights the need for selecting high-quality breeding stock for better productivity. v. **Healthcare** Emphasizes the role of veterinary care, vaccines, and disease prevention vi. **Water Supply** Explains the need for a reliable and clean water source for drinking and cleaning purposes.	Any 2 points for 3 marks i. **Pastureland** Describes the importance of adequate grazing land and forage crops for feeding ruminants. ii. **Housing/Shelter** Details on how to design suitable housing to protect animals from weather and predators. iii. **Financial Capital** Explains sources of funding or investment required for starting and sustaining the farm. iv. **Breeding Stock** Highlights the need for selecting high-quality breeding stock for better productivity. v. **Healthcare** Emphasizes the role of veterinary care, vaccines, and disease prevention vi. **Water Supply** Explains the need for a reliable and clean water source for drinking and cleaning purposes.	Any 1 point for 1.5 marks i. **Pastureland:** Describes the importance of adequate grazing land and forage crops for feeding ruminants. ii. **Housing/Shelter:** Details on how to design suitable housing to protect animals from weather and predators. iii. **Financial Capital** Explains sources of funding or investment required for starting and sustaining the farm. iv. **Breeding Stock:** Highlights the need for selecting high-quality breeding stock for better productivity. v. **Healthcare:** Emphasizes the role of veterinary care, vaccines, and disease prevention vi. **Water Supply:** Explains the need for a reliable and clean water source for drinking and cleaning purposes.

Market Needs for Ruminant Products	Any 4 points for 6 marks i. **Demand Analysis** Identifies local and global demand for meat, milk, wool, and hides. ii. **Consumer Preferences** Explains the importance of understanding consumer preferences for quality, taste, and packaging. iii. **Market Access** Discusses transportation and accessibility to urban and rural markets. iv. **Pricing Strategy** Highlights competitive pricing and profitability analysis. v. **Value Addition** Explores processing opportunities like cheese, yogurt, and leather production. vi. **Sustainability** Mentions the importance of aligning production with environmental and ethical standards.	Any 3 points for 4.5 marks i. **Demand Analysis** Identifies local and global demand for meat, milk, wool, and hides. ii. **Consumer Preferences** Explains the importance of understanding consumer preferences for quality, taste, and packaging. iii. **Market Access** Discusses transportation and accessibility to urban and rural markets. iv. **Pricing Strategy** Highlights competitive pricing and profitability analysis. v. **Value Addition** Explores processing opportunities like cheese, yogurt, and leather production. vi. **Sustainability** Mentions the importance of aligning production with environmental and ethical standards.	Any 2 points for 3 marks i. **Demand Analysis** Identifies local and global demand for meat, milk, wool, and hides. ii. **Consumer Preferences** Explains the importance of understanding consumer preferences for quality, taste, and packaging. iii. **Market Access** Discusses transportation and accessibility to urban and rural markets. iv. **Pricing Strategy** Highlights competitive pricing and profitability analysis. v. **Value Addition** Explores processing opportunities like cheese, yogurt, and leather production. vi. **Sustainability** Mentions the importance of aligning production with environmental and ethical standards.	Any 1 point for 1.5 marks i. **Demand Analysis:** Identifies local and global demand for meat, milk, wool, and hides. ii. **Consumer Preferences:** Explains the importance of understanding consumer preferences for quality, taste, and packaging. iii. **Market Access:** Discusses transportation and accessibility to urban and rural markets. iv. **Pricing Strategy:** Highlights competitive pricing and profitability analysis. v. **Value Addition:** Explores processing opportunities like cheese, yogurt, and leather production. vi. **Sustainability:** Mentions the importance of aligning production with environmental and ethical standards.

Presentation	All 4 points for 4 marks i. **Clarity Report** is clear, concise, and free of jargon. ii. **Organization** Follows a logical structure (introduction, content, conclusion). iii. **Formatting** Includes headings, subheadings, and appropriate formatting. iv. **Language** Uses professional and grammatically correct language.	Any 3 points for 3 marks i. **Clarity Report** is clear, concise, and free of jargon. ii. **Organization** Follows a logical structure (introduction, content, conclusion). iii. **Formatting** Includes headings, subheadings, and appropriate formatting. iv. **Language** Uses professional and grammatically correct language.	Any 2 points for 2 marks i. **Clarity Report** is clear, concise, and free of jargon. ii. **Organization** Follows a logical structure (introduction, content, conclusion). iii. **Formatting** Includes headings, subheadings, and appropriate formatting. iv. **Language** Uses professional and grammatically correct language.	Any 1 point for 1 mark i. **Clarity Report** is clear, concise, and free of jargon. ii. **Organization:** Follows a logical structure (introduction, content, conclusion). iii. **Formatting:** Includes headings, subheadings, and appropriate formatting. iv. **Language:** Uses professional and grammatically correct language.

APPENDIX Q: TABLE OF SPECIFICATION FOR MID-SEM EXAMS, SECOND SEM

Nature of the quiz

The test should include the following

Section A- (10 Multiple choice questions)

Section B- (2 Essay questions)

Section C- (1 Practical question)

Time: 1 hour

TABLE OF SPECIFICATION FOR MID-SEM EXAMS, SECOND SEM

Cover content from weeks 13-17, taking into consideration DoK levels 1-4.

Weeks	Learning indicators(s)	Type of Questions	DoK Levels				Total
			1	2	3	4	
13	Produce at least one arable crop from cereals, legumes and tubers	Multiple Choice	-	1	-	-	1
14	Produce at least one arable crop from cereals, legumes and tubers	Multiple Choice	1	1	1	-	3
		Practical			1		1
15	Carry out required post-harvest practices and market produce	Multiple Choice	1	-	1	-	2
		Essay		1			1
16	Identify resources and market needs for small ruminants.	Multiple Choice	1	1	-	-	2
17	Produce small ruminants (sheep or goats) common in the locality for meat.	Multiple Choice	1	1			2
		Essay			1		1
18	Outline various distribution outlets and ways of marketing meat and other products of small ruminants						
	Total		4	5	4	0	13
	%		30	40	30		100

NB. Modify, complete and use this table to set your mid-semester examination questions**.**

APPENDIX R: STEPS TO CONDUCT RESEARCH ON GRASSCUTTER REARING

1. **Introduction and Background**
   - **a. Purpose of Research:** Students should begin by exploring why grasscutter rearing is important in Ghana. This includes its relevance to local economies, meat production, food security, and environmental sustainability.
   - **b. Research Questions**
     - i. What is grasscutter farming, and how is it done in Ghana?
     - ii. What are the advantages of rearing grasscutters over other livestock?
     - iii. How does grasscutter farming contribute to income generation in Ghana?
     - iv. What are the key challenges faced by grasscutter farmers in Ghana?
2. **Research Design and Methodology**
   - **a. Research Type:** This should be a practical research project where students observe and possibly experiment with grasscutter farming techniques. Field visits to local grasscutter farms would be beneficial.
   - **b. Data Collection**
     - i. **Primary Data**
       - Interviews with local grasscutter farmers, agricultural experts, or extension officers to understand the farming practices, costs, challenges, and benefits.
       - Surveys or questionnaires could be distributed to grasscutter farmers to gather information on feeding, breeding, housing, and marketing.
       - Direct observation of farms: Students should observe how grasscutters are housed, fed, and reared for meat production.
     - ii. **Secondary Data**
       - Literature review on grasscutter rearing from agricultural journals, books, and online resources.
       - Data from the Ministry of Agriculture or research institutions on grasscutter farming in Ghana.
       - Use reports or studies from international organizations like FAO to understand the global perspective of small-scale farming of grasscutters.
3. **Research Areas/Sections**
   - **a. Grasscutter Biology and Habitat**
     - i. Discuss the biology of grasscutters, including their diet, behaviour, and natural habitat.
     - ii. Explore how the natural habitat of grasscutters can be mimicked in a farming environment for better productivity.

b. Grasscutter Breeding

i. Investigate how grasscutters are bred.

ii. Explore the breeding cycle, mating, and gestation period of grasscutters.

iii. Research how to manage their reproduction to ensure maximum yield.

c. Feeding and Nutrition

i. Research the nutritional needs of grasscutters and the type of feed available in Ghana.

ii. Study how to formulate affordable, balanced diets using local resources such as grasses, vegetables, and crop residues.

iii. Investigate how feeding practices affect growth rate and meat quality.

d. Housing

i. Explore how grasscutters are housed, focusing on space requirements, ventilation, temperature, and hygiene.

ii. Investigate affordable housing structures and materials that can be used for grasscutter farms.

e. Health and Disease Management

i. Research common diseases that affect grasscutters in captivity and how to manage or prevent them.

ii. Investigate vaccination and treatment options available for grasscutter farmers.

f. Marketing and Economics

i. Explore the market demand for grasscutter meat in Ghana.

ii. Investigate how much it costs to set up and maintain a grasscutter farm (initial investment, recurring costs like feed and medical care).

iii. Research the profitability of grasscutter farming, including the average price per grasscutter or per kilogram of grasscutter meat.

g. Environmental Impact

i. Explore how grasscutter farming can be done sustainably, minimizing environmental degradation.

ii. Investigate if grasscutter farming could be an alternative to bushmeat hunting, which contributes to deforestation and wildlife depletion.

4. **Practical Activities/Experiments**

i. Field Visits to Farms: Organize visits to local grasscutter farms so students can observe rearing techniques firsthand.

ii. Small-Scale Grasscutter Rearing Project: If resources allow, set up a small-scale grasscutter farm at the school where students can take part in feeding, breeding, and housing the animals. This hands-on experience will help students understand the daily challenges and operations of grasscutter farming.

iii. Feeding Trials: Students can experiment with different types of locally available feed to see which works best for grasscutter growth.

5. **Data Analysis and Interpretation**

   a. **Data on Growth and Health:** Analyse the data collected on grasscutter growth rates, health, and reproduction. Compare with standards from research or interviews.

   b. **Economic Analysis:** Assess the profitability of grasscutter farming based on the cost of setting up a farm, operational costs, and the market price for grasscutter meat.

   c. **Observations:** Discuss any challenges observed during the research and provide recommendations for overcoming them.

6. **Conclusion and Recommendations**

   a. **Summary:** Summarize the findings on grasscutter rearing and how feasible it is as a farming practice for students or small-scale farmers.

   b. **Recommendations:** Offer suggestions on how grasscutter farming can be improved or scaled, including better farming practices, training for farmers, or government support.

7. **Presentation**

The final output of the research can be presented in the following format

a. A written report summarising the research findings, complete with charts, tables, and photos.

b. A class presentation where students present their findings and demonstrate knowledge of grasscutter farming.

c. Practical demonstrations if a small-scale project is set up at the school.

SECTION 7: SUPPORT SYSTEMS IN AGRICULTURE

Strand: Mobilisation of Resources and Networks

Sub-Strand: Support Systems in Agriculture

Learning Outcome: Explain the different types of support systems in arable crop (cereals, legumes and tubers) production and marketing

Content Standard: *Demonstrate knowledge and understanding of the different types of support systems in arable crops (cereals, legumes and tubers) production and marketing.*

Strand: Mobilisation of Resources and Networks

Sub-Strand: Support Systems in Agriculture

Learning Outcome: Evaluate the impact of extension services on arable crop enterprises in the community

Content Standard: *Demonstrate knowledge and understanding of the approaches and methods of agricultural extension delivery.*

Hint

Remind learners to submit their individual project in week 21. Remind learners to submit their portfolio in week 23

INTRODUCTION AND SECTION SUMMARY

Organisations that support agriculture are important in Ghana as they provide various forms of assistance to farmers, traders and processors. These supports enhance productivity, profitability and sustainability of agriculture, contributing to food security and economic growth. This section is, therefore, designed to introduce learners to support organisations available in the agricultural sector and the assistance they give to farmers. The aim of this section is to help learners gain adequate knowledge about the support organisations and assistance they can get from them as prospective stakeholders in the agricultural sector. The section begins with the identification of local and international support organisations and their contributions towards arable crop production. The section progresses to the stakeholders, their interactions and linkages in the agricultural commodity value chain. The learners are expected to demonstrate in-depth knowledge in the components, functions and importance of the Agricultural Knowledge and Innovation System (AKIS).

The weeks covered by the section are:

Week 21: *Identify all relevant support organisations that offer various services to key stakeholders such as farmers, traders and processors.*

Week 22: *Describe the interactions among the various key stakeholders in the commodity value chain.*

Week 23: *Describe the Agricultural Knowledge and Information Systems (AKIS) approach and methods.*

SUMMARY OF PEDAGOGICAL EXEMPLARS

Effective teaching about support organisations in agriculture, stakeholder interactions and linkages in the agricultural commodity value chain and Agricultural Knowledge and Innovation System require the adoption of appropriate pedagogical strategies that foster deep understanding, critical thinking and practical application. By engaging learners through practical, interactive and collaborative methods, teachers can equip the future agricultural professionals with skills and knowledge needed to thrive in the agricultural sector or pursue further academic activities. The pedagogical strategies proposed in this section include digital learning, talk for learning, field visits, project-based learning, stakeholder simulations (role plays) and collaborative learning. Teachers should consider the diverse cultural background and abilities of the leaners when using these pedagogical strategies to ensure all learners participate and get the maximum benefits of the lesson. Teachers should set classroom ethics and rules for learners when using these approaches to guide learners to focus on the goals of the lessons.

ASSESSMENT SUMMARY

Assessing learners' understanding of support organizations in agriculture, stakeholder interactions and the agricultural value chain requires a diverse range of assessment techniques that capture both theoretical knowledge and practical application. Effective assessment strategies should include formative assessments, such as quizzes, class exercises, individual and group assignments to ascertain learners' understanding and provide timely feedback. Summative assessments, such as case study analyses, project-based work and stakeholder simulation exercises should be used to allow learners to demonstrate their ability to apply concepts in real-world scenarios. Additionally, peer evaluations and group presentations should be deployed to foster collaborative skills and deeper engagement with the concepts learned. By utilising these varied assessment methods, the needs of all learners can adequately be addressed. This will also ensure a comprehensive evaluation of learners' grasp of the agricultural knowledge and innovation system, preparing them for effective future academic endeavour and agricultural projects.

Week 21

Learning Indicator: Identify all relevant support organisations that offer various services to key stakeholders such as farmers, traders and processors

Focal Area: Support organisations for arable crop farmers, traders and processors

1. **Governmental and local non-governmental organisations (NGOs) supporting arable crop farmers, traders and processors.**

Governmental and local organisations in Ghana substantially support arable crop farmers, traders and processors through various programmes, initiatives and services. These efforts aim to enhance productivity, improve livelihoods and promote market access. The following are some of the organisations and the support they provide.

a. Council for Scientific and Industrial Research (CSIR)

i. Research and development: Developing improved crop varieties, pest-resistant varieties, and sustainable farming practices through its seven agriculture-related institutes.

ii. Technical assistance: Providing scientific and technical support to farmers and processors to enhance productivity and product quality.

b. Ministry of Food and Agriculture (MoFA)

i. Extension services: MoFA provides agricultural extension services to educate farmers on modern farming techniques, pest management and best practices.

ii. Input subsidy programmes: Initiatives like the Planting for Food and Jobs (PFJ) offer subsidised seeds, fertilisers and other inputs to boost crop production.

iii. Training and capacity building: Regular training programmes for farmers on improved agricultural practices, post-harvest management and value addition.

iv. Market access facilitation: Assistance in finding markets for farm produce, including organising trade fairs and linking farmers to buyers.

c. Ghana Irrigation Development Authority (GIDA)

i. Irrigation infrastructure: Development and maintenance of irrigation systems to ensure reliable water supply for crop farming, especially in drier regions.

ii. Technical support: Training farmers on efficient water management and irrigation techniques.

d. Peasant Farmers Association of Ghana (PFAG)

i. Advocacy: Representing the interests of small-scale farmers, lobbying for favourable policies and support from the government.

ii. Capacity building: Offering training and resources to improve farming techniques, productivity and business management skills.

e. Farmer Based Organisations (FBOs)

i. Cooperative activities: Enabling farmers to pool resources, access inputs and collectively market their produce.

ii. Training and support: Provide training on modern agricultural techniques, financial management and market strategies.

f. Ghana National Association of Farmers and Fishermen (GNAFF)

i. Representation and advocacy: Advocating for the needs and interests of farmers at national and local levels.

ii. Support services: Providing access to training, inputs and markets for farmers and processors.

g. Women in Agricultural Development (WIAD)

i. Gender-focused programmes: Empowering women in agriculture through training, resource provision and advocacy for gender-sensitive policies.

ii. Support services: Offering specific support for women farmers and processors, including access to credit, inputs and markets.

h. Ghana Agricultural Sector Investment Programme (GASIP)

i. Integrated support: GASIP, implemented by MoFA with IFAD support, provides comprehensive support to smallholder farmers, including infrastructure development, market access and capacity building.

ii. Value chain development: Enhancing value chains for various crops to improve efficiency, reduce post-harvest losses and increase incomes.

i. Northern Rural Growth Programme (NRGP)

i. Rural development focus: Aiming to improve livelihoods in northern Ghana through agricultural development, infrastructure improvement and market access.

ii. Support for processors: Assisting processors with training, access to equipment and market linkages to enhance value addition.

j. Ghana Investment Promotion Centre (GIPC)

i. Investment promotion: Attracting investments in the agricultural sector, including funding opportunities and incentives for agribusinesses.

ii. Support services: Offering advisory services and facilitating partnerships between local farmers/processors and foreign investors.

k. National Board for Small-Scale Industries (NBSSI)

i. Business development services: Providing training, financial literacy programmes and capacity building for small-scale farmers and processors.

ii. Access to finance: Facilitating access to credit and financial services tailored to the needs of agricultural enterprises.

l. Ghana Standards Authority (GSA)

i. Certification of agricultural products: GSA certifies agrarian products to meet national and international standards. This helps farmers sell their products in foreign markets.

ii. Standards compliance support: Helps traders understand and comply with the standards required for exporting products to international markets

iii. Product quality assessment and verification: Ensures that products traded domestically and internationally meet the required quality and safety standards.

2. **Roles of International Organisations Involved in Agriculture Development in Ghana**

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

a. **Funding and investment**

i. World Bank: The World Bank provides substantial financial support for agricultural projects in Ghana. For instance, the Ghana Commercial Agriculture Project (GCAP) aims to improve productivity and market access for smallholder farmers.

ii. International Fund for Agricultural Development (IFAD): IFAD supports rural development projects in Ghana, focusing on improving the livelihoods of small-scale farmers. Their programmes often target poverty reduction and food security.

iii. Agricultural Development Bank (AfDB): Offer tailored financial products and services, including loans, savings and insurance for farmers and agribusinesses.

b. **Technical assistance and capacity building**

i. Food and Agriculture Organisation (FAO): FAO offers technical expertise and capacity-building programmes to improve agricultural practices, pest control, and sustainable farming methods. They also assist in policy formulation and implementation.

ii. International Fertiliser Development Centre (IFDC): IFDC promotes soil fertility and agricultural productivity through sustainable fertiliser use and soil health practices.

c. **Research and innovation**

i. 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, carry out research on crop and animal improvement, pest management, and policy analysis to support Ghana's agricultural development.

ii. USAID (United States Agency for International Development): Through its Feed the Future initiative, USAID funds research and development projects on improving agricultural productivity and resilience to climate change.

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

d. **Infrastructure development**

i. AfDB: Finances infrastructure projects that support agricultural development, including irrigation systems, rural roads and market facilities. These projects aim to reduce post-harvest losses and improve market access for farmers.

ii. European Union (EU): The EU supports agricultural infrastructure development through various projects and programmes, focusing on improving the overall agriculture value chain.

e. **Policy and advocacy**

i. United Nations Development Programme (UNDP): 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.

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

f. **Market access and trade facilitation**

i. International Trade Centre (ITC): ITC helps Ghanaian farmers and agribusinesses access international markets through training on quality standards, packaging and marketing. They also facilitate trade missions and partnerships.

ii. World Trade Organization (WTO): The WTO works with the Ghanaian government to enhance trade policies and regulations, making it easier for agricultural products to reach foreign markets.

g. **Climate change and sustainability support**

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

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

h. **Emergency relief and resilience building**

i. International Red Cross Society and Red Crescent Movement: They provide emergency relief during agricultural crises, such as pest outbreaks, droughts and floods and work on building community resilience to future shocks.

ii. World Vision and other NGOs: World Vision International and other non-governmental organisations collaborate to provide emergency assistance, support agricultural recovery and enhance long-term resilience.

Learning Tasks

1. Learners to browse the Internet to identify support organisations for arable crop farmers, traders and processors.
2. Learners to classify the support organisations as governmental, non-governmental and international organisations.
3. Learners to discuss the support these organisations offer to farmers, traders and processors.
4. Learners to make a checklist of the organisations and their functions.

Pedagogical Exemplars

1. **Enquiry-based learning:** Learners in mixed ability groups surf the Internet to list the support organisations involved in agriculture and classify them as national and international organisations Teachers should guide learners with probing questions to assist learners in difficulty and encourage more confident learners to lead the groups.
2. **Talk for learning:** Learners in mixed-ability groups discuss the roles of the organisations and present reports. Teachers should support learners with discussion prompts to guide learners to focus on the lesson.

Key Assessments

Assessment Level 1: List six support organisations involved in agriculture

Assessment Level 2: Differentiate between governmental and non-governmental organisations involved in agriculture and give two examples of each.

Assessment Level 3: Discuss four ways organisations support farmers, traders and processors.

Assessment Level 4

1. Develop a checklist of the functions of the support organisations.
2. Make a poster of support organisations that offer various services to key stakeholders in arable crop production such as farmers, traders and processors

Hint

*The recommended mode of assessment for week 21 is **poster presentation**. Use the level 4 question 2 as a sample question.*

Week 22

Learning Indicator: Describe the interactions among the various key stakeholders in the commodity value chain

Focal Area: Stakeholder linkage and interactions

In Ghana, the agricultural commodity value chains involve many stakeholders including producers, processors, distributors, marketers and consumers. Healthy interactions between various stakeholders in the agricultural commodity value chain are essential for creating a cohesive, efficient, and responsive agricultural system. These interactions enhance communication, improve resource allocation, foster innovation, and ensure that the needs and interests of all stakeholders are addressed.

1. **Specific roles of key stakeholders in the agricultural value chain**

   a. **Farmers/producers:** They generate the raw materials as the primary commodities in the value chain. Smallholders and commercial farmers and plantation operators are involved. They engage with financial agencies, input suppliers, extension services providers, cooperatives and traders for the success of their enterprises.

   b. **Input suppliers:** Provide essential inputs such as seeds, fertilisers, pesticides, and farming equipment. Stakeholders are seed suppliers, fertiliser companies, agrochemical firms and machinery and equipment suppliers. Their input ensures the success and sustainability of producers.

   c. **Extension services:** They offer technical support, training and education to farmers on modern farming techniques. Government agencies (like the Ministry of Food and Agriculture), Non-Governmental Organisations (NGOs) and private sector consultants are involved. They liaise with farmers, research institutions and development agencies to improve production.

   d. **Research and development institutions:** 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 Organizations. They collaborate with extension services and farmers to disseminate and commercialise new technologies.

   e. **Cooperatives and farmer organisations:** They support farmers, negotiate with buyers and facilitate access to finance and inputs. The Ghana National Association of Farmers and Fishermen (GNAFF) and the Farmer-Based Organisation (FBO) Peasant Farmers Association of Ghana are examples.

   f. **Traders:** Purchase and aggregate produce from producers for resale to processors, and consumers. They include middlemen, wholesalers and retailers. Traders engage with farmers, cooperatives, processors and exporters to facilitate the flow of produce.

   g. **Processors:** 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 source raw materials from producers and traders, collaborate with packaging companies and engage with wholesalers and retailers.

h. **Consumers:** Purchase and consume agricultural produce and products. This involves individual households, restaurants, hotels and institutions. They influence market demand and provide feedback through purchasing behaviours and preferences.

i. **Financial institutions:** Commercial banks, microfinance institutions and rural banks provide credit and financial services to various stakeholders. They offer loans and financial products to farmers, cooperatives and agribusinesses and collaborate with development agencies for funding.

j. **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.

k. **NGOs and development agencies:** Support agricultural development through 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.

l. **Exporters:** Facilitate the export of agricultural products to foreign markets. They collaborate with traders, processors and government agencies to meet export standards and access foreign markets.

2. **Strategies to enhance stakeholder linkages**

a. **Strengthening cooperatives:** Empowering farmer cooperatives can enhance collective bargaining power, improve access to markets and facilitate better resource management.

b. **Improving access to information:** Utilising ICT tools to provide real-time information on weather forecasts, best agricultural practices and market prices, can improve decision-making for all stakeholders.

c. **Facilitating financial inclusion:** Developing tailored financial products for different stakeholders can improve access to credit and investment in the value chain.

d. **Promoting public-private partnerships:** Encouraging collaboration between government, private sector and NGOs can leverage resources and expertise for sustainable value chain development.

e. **Enhancing infrastructure:** Investing in transportation, storage and processing infrastructure can reduce post-harvest losses and improve the efficiency of the value chain.

f. **Policy and regulatory support:** Implementing favourable policies and regulations can create an enabling environment for value chain development.

3. **Relevance of the interactions between various stakeholders in the agricultural commodity value chain**

Interactions between various stakeholders in the agricultural commodity value chain are crucial for the efficiency, sustainability and overall success of the agricultural sector. These interactions facilitate the flow of information, resources and services, enabling each stakeholder to perform their role more effectively. Some interactions and their relevance

a. **Research and extension institutions and farmers**

   i. Problem-solving: Research institutions together with farmers and extensionists work on solving specific problems faced by farmers, such as pest infestations, soil degradation and climate change impacts.

   ii. 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.

b. **Farmers and input suppliers**

   i. Access to quality inputs: Farmers rely on input suppliers for seeds, fertilisers, pesticides, and machinery. Effective interactions ensure farmers receive high-quality inputs that are essential for crop productivity.

   ii. Technical support: Input suppliers often provide technical advice on the proper use of inputs, which can enhance farm productivity and sustainability.

c. **Farmers and extension services**

   i. 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.

   ii. Adoption of innovations: Regular interactions encourage the adoption of innovative farming techniques and practices, which can lead to increased productivity and profitability.

d. **Farmers and financial institutions**

   i. Access to credit: Financial institutions provide the necessary capital for purchasing inputs, investing in technology and expanding operations. Effective interactions ensure that farmers have access to affordable credit.

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

e. **Farmers and cooperatives**

   i. Collective bargaining: Cooperatives help farmers negotiate better prices for inputs and produce, reducing costs and increasing income.

   ii. Resource sharing: Cooperatives facilitate the sharing of resources such as machinery, storage facilities and transportation, leading to cost savings and efficiency.

f. **Farmers and processors**

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

   ii. Quality standards: Processors often set quality standards that farmers must meet, encouraging the adoption of better farming practices and quality control measures.

g. **Processors and distributors**

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

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

h. **Government and all stakeholders**

i. 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.

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

i. **Non-Governmental Organisations (NGOs) and stakeholders**

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

ii. Advocacy: NGOs advocate for the rights and interests of smallholder farmers and other vulnerable groups, ensuring their voices are heard in policy-making processes.

j. **Consumers and producers**

i. Demand and preferences: Consumer preferences and demand patterns influence production decisions. Direct interactions, such as through farmers' markets or consumer feedback mechanisms, help producers align their produce with market needs.

ii. Food safety and quality: Consumers' increasing focus on food safety and quality drives producers to adopt better practices and standards.

Learning Tasks

1. Learners to list the key stakeholders involved in the agricultural value chain.
2. Learners to explain the interactions among the stakeholders involved in the value chain.
3. Learners to discuss strategies for enhancing the stakeholder linkages along the value chain.
4. Learners to evaluate the relevance of the interactions among the stakeholders involved in the value chain.

Pedagogical Exemplars

1. **Collaborative learning:** Put learners in mixed-ability groups and guide them with probing questions to identify and explain the roles of the key stockholders involved in the agricultural value chain and present their findings to the class. Guide learners to choose leaders to lead the groups to guide their focus on the goals of the discussion.
2. **Structured talk for learning:** Learners in their original groups discuss the relevance of the stakeholder interactions along the agricultural value chain and present their findings to the class. Teachers should support learners having difficulty with leading questions.

3. **Role play/dramatisation:** Assign different stakeholder roles (producers, processors, storage facility operators, distributors, retailers, support organisations) to each of the groups and guide them to practise and dramatise to the class. Teachers should guide learners to demonstrate the stakeholder linkages and interactions in the role play.

Key Assessments

Assessment Level 1

1. Solve the following Multiple-Choice Questions (MCQs) on the interactions among the various key stakeholders in the agricultural commodity value chain.

   Which of the following strategies can enhance stakeholder linkages in the agricultural value chain?

   a. Decreasing access to information for farmers
   b. Limiting financial inclusion
   c. Promoting public-private partnerships
   d. Reducing government involvement,

2. List five key stakeholders involved in the agricultural value chain.

Assessment Level 2: Explain the roles of three key stakeholders involved in the agricultural value chain.

Assessment Level 3: Discuss three main stakeholder linkages in the agricultural value chain.

Assessment Level 4: Evaluate the relevance of stakeholder interactions in the agricultural value chain.

Hint

*The recommended mode of assessment for week 22 is **multiple choice questions**. Use the level 1 question 1 as a sample question.*

Week 23

Learning Indicator: Describe the Agricultural Knowledge and Innovation Systems (AKIS) approach and methods

Focal Area: Importance of Agricultural Knowledge and Innovation Systems in Extension Delivery

Agricultural Knowledge and Information Systems (AKIS) in extension delivery is a framework that integrates various sources of knowledge generation, information dissemination and application to support and improve agricultural practices and outcomes. AKIS involves the people, institutions, technologies and processes in innovation development, extension and application. It supports farmers, extension workers, researchers, and policymakers by facilitating the flow of information and fostering innovation and resources needed to enhance their productivity, sustainability, and livelihoods.

1. **Key components of AKIS**

    a. **Knowledge creation:** Research Institutions, universities and agricultural organisations carry out research to develop new technologies, practices, and solutions to agricultural challenges. Farmers can contribute their local knowledge and experiences, leading to the co-creation of solutions that are practical and effective.

    b. **Knowledge dissemination:** Extension agents and services act as intermediaries in translating research findings into practical advice and disseminating information to farmers. Workshops, field days, and training sessions are organised to educate farmers on new techniques and technologies. Digital platforms like websites, mobile apps, and social media provide access to agricultural information and connect farmers with experts and peers.

    c. **Knowledge utilisation:** Farmers, Agricultural Cooperatives, Processors, Agribusinesses, Youth in Agriculture, traders and marketers apply the knowledge and practices shared through AKIS to improve their production, distribution and processing.

2. **Roles of AKIS in extension delivery**

    a. **Information sharing:** This ensures farmers receive timely, up-to-date and relevant 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.

    b. **Capacity building:** AKIS facilitates continuous learning through training programmes, workshops, Farmer Field Schools and Fora and educational materials for farmers and extensionists for upgrade of skills and knowledge.

    c. **Innovation and technology transfer:** AKIS bridges gaps between researchers and farmers, facilitating the transfer of innovations.

    d. **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 ensures better risk management.

e. **Policy and programme support:** Policymakers rely on AKIS data to formulate agricultural policies and programmes. Stakeholders engage to promote a coordinated approach to agricultural development.

3. **Importance of AKIS in extension delivery**

a. **Support for innovation:** AKIS promotes the development and dissemination of new technologies and practices, helping farmers adopt innovative approaches that enhance productivity and efficiency.

b. **Enhanced research-extension linkage:** The communication channels between researchers, extension agents and farmers are strengthened for easier information flow.

c. **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. It establishes feedback mechanisms where farmers can provide input on extension services, ensuring continuous improvement.

d. **Increased adoption of best practices:** It helps in the adoption of best agricultural practices which lead to increased productivity and sustainability.

e. **Resource optimisation:** It helps farmers optimise resources such as water, fertilisers and labour, reducing waste and increasing sustainability.

f. **Promotes sustainable agriculture:** AKIS encourages the adoption of sustainable farming practices that protect natural resources, reduce negative environmental impact, and ensure the long-term viability of agricultural systems.

g. **Community networking and development:** AKIS helps build networks and fosters collaboration among farmers, extension agents, researchers, agribusinesses, policymakers and other stakeholders, promoting community development and collective problem-solving.

h. **Increased productivity:** Access to innovative practices through AKIS can lead to larger crop yields, improved livestock production and better overall farm management.

i. **Risk management:** By providing information on weather patterns, pest outbreaks and market fluctuations, AKIS helps farmers manage risks and reduce their vulnerability to adverse events.

j. **Capacity building:** AKIS supports the education and training of farmers, extension workers and other stakeholders, enhancing their skills and knowledge and empowering them to implement innovative solutions.

k. **Policy development:** Policymakers rely on the data and insights generated by AKIS to design and implement policies that promote agricultural development, food security, and sustainable rural livelihoods.

Learning Tasks

1. Learners to identify the key components of AKIS.
2. Learners to explain the importance of AKIS in agricultural production.
3. Learners discuss the roles of AKIS in agricultural production

Pedagogical Exemplars

1. **Structured talk for learning:** Learners in mixed ability groups study cases of Agricultural Knowledge and information systems (AKIS) approach and methods in extension delivery. They should identify the key components of AKIS and present reports in a plenary session.
2. **Group project work:** In mixed groups, learners develop a mini-AKIS model tailored to a specific agricultural issue or region. Learners should apply theoretical knowledge to a practical problem and understand the components and processes involved in AKIS.
    - Each group will identify an agricultural issue or select a region with specific challenges the class will identify.
    - They will research and design a model that includes knowledge creation, dissemination, and utilisation components. The model should address how different stakeholders (researchers, extension agents, farmers, policymakers) will interact and collaborate.
    - Groups will present their models to the class, explaining their design and the expected outcomes.
    - The concept should be explained for all learners to understand clearly.

Key Assessments

Assessment Level 1: List five roles of AKIS in extension delivery.

Assessment Level 2: Outline the importance of AKIS in extension delivery.

Assessment Level 3: Explain the benefits of relying on AKIS in agricultural production.

Assessment Level 4: Outline how AKIS can help communities to develop.

Hint

*The recommended mode of assessment for week 23 is **portfolio assessment**. Use the level 4 question 2 as a sample question.*

SECTION 7 REVIEW

Teaching support organisations in the agricultural sector, stakeholder interactions and linkages in the agricultural commodity value chain were essential for developing a comprehensive understanding of the agricultural sector. Through these concepts, learners gain insights into the diverse roles the support organisations play, such as providing financial support, training, research and market access. In addition, teaching stakeholder interactions and linkages in the agricultural value chain emphasised the interconnectedness of various actors, from farmers to consumers. This approach highlighted the importance of collaboration and coordination in enhancing efficiency and adding value to agricultural products. Understanding the components and functions of AKIS allowed learners to appreciate how innovation and knowledge dissemination drive development. By exploring these concepts, learners are better prepared to engage with and contribute to the sector, fostering sustainable growth and development.

APPENDIX R: MARKING SCHEME FOR THE PORTFOLIO ASSESSMENT TASK

Structure and organisation of the portfolio assessment

As part of the structure of the portfolio assessment, make sure the following information has been provided

a. Cover Page which entails the learner's name, ID, class, subject and period/date.

b. Table of Contents which has the list of items included with page numbers.

c. Brief description/background of items such as short description of the significance of sports certificates and awards, background information for each included artefact, etc.

Example of learners' works to be included in the Portfolio Assessment

a. Assignments

b. Reports of Projects

c. Quizzes and Tests

d. Posters

e. Mid semester and end of semester papers

Section of portfolio	Score
Assignments/Exercises	10 marks
Reports of Projects	10 marks
Quizzes and Tests	10 marks
Posters	10 marks
Mid-semester and End-of-semester Papers	10 marks
Total marks	**50 marks**

RUBRICS FOR THE POSTER PRESENTATION ASSESSMENT TASK

Criteria	Excellent (4 Marks)	Very Good (3 Marks)	Good (2 Marks)	Fair (1 Mark)
Title and Introduction	All 4 points for 4 marks **Title** i. Empowering Agriculture ii. Support Organizations for Farmers, Traders, and Processors **Introduction** iii. The agricultural sector relies on the collaboration of various organizations to address challenges and promote sustainable development. iv. This poster highlights governmental bodies, NGOs, and international organizations that offer critical support services, playing a pivotal role in the growth of the agricultural industry.	Any 3 points for 3 marks **Title** i. Empowering Agriculture ii. Support Organizations for Farmers, Traders, and Processors **Introduction** iii. The agricultural sector relies on the collaboration of various organizations to address challenges and promote sustainable development. iv. This poster highlights governmental bodies, NGOs, and international organizations that offer critical support services, playing a pivotal role in the growth of the agricultural industry.	Any 2 points for 2 marks **Title** i. Empowering Agriculture ii. Support Organizations for Farmers, Traders, and Processors **Introduction** iii. The agricultural sector relies on the collaboration of various organizations to address challenges and promote sustainable development. iv. This poster highlights governmental bodies, NGOs, and international organizations that offer critical support services, playing a pivotal role in the growth of the agricultural industry.	Any 1 point for 1 mark **Title** i. Empowering Agriculture ii. Support Organizations for Farmers, Traders, and Processors **Introduction** iii. The agricultural sector relies on the collaboration of various organizations to address challenges and promote sustainable development. iv. This poster highlights governmental bodies, NGOs, and international organizations that offer critical support services, playing a pivotal role in the growth of the agricultural industry.

Governmental and Local NGOs Supporting Farmers, Traders, and Processors	Includes at least 4 organizations, each described with relevant roles (e.g., i. Council for Scientific and Industrial Research **(CSIR)** ii. Ministry of Food and Agriculture **(MoFA)** iii. Ghana Irrigation Development Authority **(GIDA)** iv. Peasant Farmers Association of Ghana **(PFAG)** v. Ghana Investment Promotion Centre (GIPC) **NB. Any 4 of the above for 2 marks** i. Descriptions are precise, highlighting key contributions Example ii. Subsidies, iii. Policy advocacy, iv. Capacity-building. v. Funding and investment vi. Research and innovation vii. Market access and trade facilitation **NB. Any 4 of the above for 2 marks** **Total = 4 Marks**	Includes at least 3 organizations, each described with relevant roles (e.g., i. Council for Scientific and Industrial Research **(CSIR)** ii. Ministry of Food and Agriculture **(MoFA)** iii. Ghana Irrigation Development Authority **(GIDA)** iv. Peasant Farmers Association of Ghana **(PFAG)** v. Ghana Investment Promotion Centre (GIPC) **NB. Any 3 of the above for 1.5 marks** i. Descriptions are precise, highlighting key contributions Example ii. Subsidies, iii. Policy advocacy, iv. Capacity-building. v. Funding and investment vi. Research and innovation vii. Market access and trade facilitation **NB. Any 3 of the above for 1.5 marks** **Total = 3 Marks**	Includes at least 2 organizations, each described with relevant roles (e.g., i. Council for Scientific and Industrial Research **(CSIR)** ii. Ministry of Food and Agriculture **(MoFA)** iii. Ghana Irrigation Development Authority **(GIDA)** iv. Peasant Farmers Association of Ghana **(PFAG)** v. Ghana Investment Promotion Centre (GIPC) **NB. Any 2 of the above for 1 mark** i. Descriptions are precise, highlighting key contributions Example ii. Subsidies, iii. Policy advocacy, iv. Capacity-building. v. Funding and investment vi. Research and innovation vii. Market access and trade facilitation **NB. Any 2 of the above for 1 mark** **Total = 2 Marks**	Includes at least 1 organization, described with relevant roles (e.g., i. Council for Scientific and Industrial Research **(CSIR)** ii. Ministry of Food and Agriculture **(MoFA)** iii. Ghana Irrigation Development Authority **(GIDA)** iv. Peasant Farmers Association of Ghana **(PFAG)** v. Ghana Investment Promotion Centre (GIPC) **NB. Any 1 of the above for 0.5 marks** i. Descriptions are precise, highlighting key contributions Example ii. Subsidies, iii. Policy advocacy, iv. Capacity-building. v. Funding and investment vi. Research and innovation vii. Market access and trade facilitation **NB. Any 1 of the above for 0.5 marks** **Total = 1 Mark**

Visual Representation	The poster depicts any 4 of these for 4 marks i. Visuals/icons for all organizations included, aiding recognition. ii. Effective use of colour coding to differentiate sections. iii. Layout is balanced and iv. aesthetically pleasing.	The poster depicts any 3 of these for 3 marks i. Visuals/icons for all organizations included, aiding recognition. ii. Effective use of colour coding to differentiate sections. iii. Layout is balanced and iv. aesthetically pleasing.	The poster depicts any 2 of these for 2 marks i. Visuals/icons for all organizations included, aiding recognition. ii. Effective use of colour coding to differentiate sections. iii. Layout is balanced and iv. aesthetically pleasing.	The poster depicts any 1 of these for 1 mark i. Visuals/icons for all organizations included, aiding recognition. ii. Effective use of colour coding to differentiate sections. iii. Layout is balanced and iv. aesthetically pleasing.
Communication Skills	Showing 4 of the skills e.g. Audible voice, Keeping eye contact Pay attention to audience Engaging the audience with interaction Use of gesture	Showing 3 of the skills e.g. Audible voice, Keeping eye contact Pay attention to audience Engaging the audience with interaction Use of gesture	Showing 2 of the skills e.g. Audible voice, Keeping eye contact Pay attention to audience Engaging the audience with interaction Use of gesture	Showing 1 of the skills e.g. Audible voice, Keeping eye contact Pay attention to audience Engaging the audience with interaction Use of gesture
Team work	Exhibit 4 of these Contributing to the group. Respecting the views of others Tolerating others Resolving conflicts Taking responsibility	Exhibit 3 of these Contributing to the group. Respecting the views of others Tolerating others Resolving conflicts Taking responsibility	Exhibit 2 of these Contributing to the group. Respecting the views of others Tolerating others Resolving conflicts Taking responsibility	Exhibit 1 of these Contributing to the group. Respecting the views of others Tolerating others Resolving conflicts Taking responsibility
Design & Creativity	The poster shows creativity and organization of any 4 of these: layout that draws attention to key points. Visuals are eye-catching, relevant, and enhance understanding of the content. Text and images are balanced and easy to follow.	The poster shows creativity and organization of any 3 of these: layout that draws attention to key points. Visuals are eye-catching, relevant, and enhance understanding of the content. Text and images are balanced and easy to follow.	The poster shows creativity and organization of any 2 of these: layout that draws attention to key points. Visuals are eye-catching, relevant, and enhance understanding of the content. Text and images are balanced and easy to follow.	The poster shows creativity and organization of any 1 of these: layout that draws attention to key points. Visuals are eye-catching, relevant, and enhance understanding of the content. Text and images are balanced and easy to follow.

SECTION 8: GLOBAL WARMING

Strand: Agriculture and Climate

Sub-Strand: Climate change variability

Learning Outcome: Analyse global warming and its threat to environmental and rural livelihood sustainability

Content Standard: *Demonstrate knowledge and understanding of global warming and its threat to environmental and rural livelihood sustainability.*

Hint

Remind learners of End of Semester Examination in Week 24. Refer to Appendix S at the end of this section for Table of specification.

INTRODUCTION AND SECTION SUMMARY

Global warming refers to the long-term rise in the Earth's average surface temperature due to human activities, particularly the emission of greenhouse gases like carbon dioxide, methane, and nitrous oxide. These emissions trap heat in the atmosphere and reflect it to the Earth, leading to the rise in temperature. The section introduces learners to 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. Learners 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. Teachers are expected to guide learners during discussions and project work.

The section covered one week:

Week 24: Describe global warming and its effect on environmental and rural livelihood sustainability.

SUMMARY OF PEDAGOGICAL EXEMPLARS

Teaching global warming and its effects on environmental and rural livelihood sustainability can be effectively accomplished using a variety of pedagogical exemplars. These will enhance active learning, critical thinking and problem-solving skills, helping learners understand climate change and its consequences. Teachers should use structured talk for learning to discuss global warming and its effects. Enquiry-based learning allows learners to evaluate case studies on climate variability and change and global warming in the community, while problem-based learning is used to assist learners in groups to design projects aimed at reducing greenhouse

gas emissions into the environment. Teachers should consider differences in learners' cultural backgrounds, gender and capabilities and structure their pedagogical approaches to benefit all of them. These pedagogical exemplars will help learners grasp the complexities of global warming and its impacts on environmental and rural livelihood sustainability, promoting active engagement and application of acquired knowledge.

ASSESSMENT SUMMARY

A comprehensive assessment strategy should be used to evaluate students' knowledge, analytical skills, creativity, and practical application on the concepts of global warming. By incorporating diverse assessment tools, teachers can ensure that learners gain a deep understanding of the subject, preparing them to address the challenges of climate change in their communities and beyond. The assessment methods include quizzes and examinations. Multiple-choice, matching and short-answer questions should be used to assess knowledge on the impact of global warming on the environment. Learners should make group presentations on their research findings on global warming, its effect on the community and how to control emissions. Teachers should employ summative assessments, including final projects, written examinations and reports, to estimate learners' overall performance at the end of the section. The teacher should provide timely and constructive feedback to help learners improve and update the transcript system with learner's performance records.

Week 24

Learning Indicator: Describe global warming and its effect on environmental and rural livelihood sustainability

Focal Area: Effect of global warming on environmental and rural livelihood sustainability

1. **Meaning of global warming:** 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.
2. **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.
    a. **Key greenhouse gases and their sources**
        i. Carbon Dioxide (CO_2): Emitted from burning fossil fuels, deforestation and certain industrial processes and exhausts.
        ii. Methane (CH_4): Released from human activities such as agriculture (especially livestock rearing), landfills, and fossil fuel extraction.
        iii. Nitrous Oxide (N_2O): Emitted from agricultural activities, industrial processes, and the burning of fossil fuels.
        iv. 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.
3. **Consequences of global warming on environmental and rural livelihood sustainability**
    a. **Global temperature rise:** Increased greenhouse gas concentrations lead to higher average global temperatures.
    b. **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.
    c. **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).
    d. **Ecosystem disruption:** Shifts in climate zones and changing weather patterns impact biodiversity and ecosystems, potentially leading to biodiversity loss and species extinction.
    e. **Ocean acidification:** Increased CO_2 levels lead to higher concentrations of carbonic acid in oceans, affecting marine life.

f. **Human health:** Increased temperatures and altered weather patterns caused by global warming can directly and indirectly affect human health, such as heat-related illnesses, spread of diseases and reduced air quality.

4. **Effects of global warming on environmental sustainability**

   a. **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.

   b. **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.

   c. **Reduced water resources:** Global warming affects the hydrological cycle, causing changes in precipitation 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

   d. **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.

   e. **Agricultural productivity:** Global warming raises temperature and reduces precipitation affecting growing seasons, soil fertility and crop yields.

   f. **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.

   g. **Livelihoods and income:** Decreased productivity and increased food costs reduce household income and economic stability.

   h. **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.

5. **Control of global warming:** Controlling global warming requires a multifaceted approach 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 CO_2 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 the 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 (CO_2) 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 that 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.

Learning Tasks

1. Learners search for and read information on global warming and find projects aimed at reducing greenhouse gas emissions before the lesson.
2. Learners to state the meaning and causes of global warming.
3. Learners to explain the effects of global warming on environmental sustainability
4. Learners design projects for reducing greenhouse gas emissions.

Pedagogical Exemplars

1. **Structured talk for learning**

- The teacher introduces the lesson on global warming and its effects on environmental sustainability by mentioning recent climate-related disasters.
- The teacher should also explain that these disasters are linked to climate change patterns due to global warming.
- Learners discuss the meaning, causes and impact of global warming on the school community.
- The teacher makes class interactive by asking leading questions to help learners take part in the discussion.
- The teacher may invite guest speakers (where available) to talk on the effect of global warming on environmental and rural livelihood sustainability.
- The teacher should ensure that each learner contributes to the discussion.

- Learners in groups discuss the salient points raised and submit reports.

2. **Enquiry-based learning**

- In mixed groups learners study a case on climate variability and change and global warming. Learners then discuss their findings in class.
- The teacher should help learners with suitable website links, where they can access the information needed for discussion. The teacher should ensure that all learners fully participate in the activity.
- The more proficient learners should be given leading roles when discussing their findings to get feedback from learners.

3. **Problem-based learning**

- Learners in their existing groups design projects aimed at reducing greenhouse gas emissions into the environment.
- Learners then make presentations at a plenary session in class.
- All learners should be encouraged to take part in the presentation.
- The teacher should monitor learners to ensure that they use the correct websites. Where necessary, the teacher should support learners with appropriate website links.

Key Assessments

Assessment Level 1: State the meaning and causes of global warming.

Assessment Level 2: Explain the impact of global warming on the community.

Assessment Level 3: Evaluate the effects of global warming on environmental sustainability

Assessment Level 4: Discuss how greenhouse gases trap heat and cause global warming.

Hint

- *The recommended mode of assessment for week 24 is **end of semester examination.***
- *Refer to Appendix H at the end of this section for Table of specification.*

SECTION 8 REVIEW

The section introduced learners to global warming and its effect on environmental and rural livelihood sustainability. Learners studied the meaning and causes of global warming and its consequences like changes in weather patterns, rising sea levels, and ecosystems and biodiversity loss. The section helped learners understand and appreciate the current extreme weather events like hurricanes, prolonged droughts and increased flooding, with consequent, food shortages, increased food prices and water shortages. Learners were also exposed to measures to control global warming, reduce greenhouse gas emissions, increase carbon sinks and implement policies and practices that promote sustainability such as energy efficiency and support for carbon pricing. The section and the chosen pedagogies were intended to improve learners' understanding of climate change and how it can be controlled for the benefit of the people. The lesson emphasised the value of responsibility to the learners.

APPENDIX H: TABLE OF SPECIFICATION FOR THE END OF SECOND SEMESTER EXAMINATION

Nature and Composition: the examination should include the following sections

Section A- (50 Multiple choice questions mainly DoK level 1-3) answer all

Section B- (5 Essay questions DoK level 2 to 4) answer any three (3)

Section C- (3 Practical question DoK Level 3- 4) answer all

Note: Duration of paper: Two (2) hours for Section A and B and One (1) hour for Section C (practical work)

Table of Specification for The End of Second Semester Examination

Hint

Cover content from weeks 13-24 learning outcomes taking DoK levels 1-4 into consideration

Weeks	Learning Indicator(s)	Type of Questions	DoK Levels				Total
			1	2	3	4	
13	Produce at least one arable crop from cereals, legumes and tubers	Multiple Choice	1	1	1	-	3
14	Produce at least one arable crop from cereals, legumes and tubers	Multiple Choice	1	2	1	-	4
15	Carry out required post-harvest practices and market produce	Multiple Choice	1	2	1	-	4
		Practical	-	-	1	-	1
16	Identify resources and market needs for small ruminants.	Multiple Choice	1	1	1	-	3
		Essay	1	-	-	-	1
17	Produce small ruminants (sheep or goats) common in the locality for meat.	Multiple Choice	1	1	1	-	3
18	Outline various distribution outlets and ways of marketing meat and other products of small ruminants	Multiple Choice	1	1	1	-	3
19	Explain the methods for rearing snails.	Multiple Choice	1	1	1	-	3
		Practical	-	-	-	1	1
20	Explain the methods for rearing grasscutters.	Multiple Choice	1	2	-	-	3
		Essay	-	-	1	-	1
21	Identify all relevant support organizations that offer various services to key stakeholders such as farmers, traders and processors.	Multiple Choice	1	2	1	-	4
		Essay	-	1			1

22	Describe the interactions among the various key stakeholders in the commodity value chain.	Multiple Choice	2	1	–	–	3
		Essay	–	–	1		1
		Practical	–	1	–	–	1
23	Describe the Agricultural Knowledge and Information Systems (AKIS) approach and methods.	Multiple Choice	1	1	1	–	3
24	Describe global warming and its effect on environmental and rural livelihood sustainability.	Multiple Choice	2	1	1	–	4
		Essay	–	1	–	–	1
		TOTAL	15	19	13	1	48
		%	30%	40%	30%		100%

NB. Modify, complete and use this table to set your examination questions

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