MINISTRY OF EDUCATION

# Agricultural Science

## For Senior High Schools

### TEACHER MANUAL

YEAR 1 - BOOK 2

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

# MINISTRY OF EDUCATION

REPUBLIC OF GHANA

# Agricultural Science

# For Senior High Schools

## Teacher Manual

### Year One - Book Two

NaCCA
NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

**AGRICULTURAL SCIENCE TEACHER MANUAL**

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# CONTENTS


**INTRODUCTION** 1

**Learner-Centred Curriculum** 1

**Promoting Ghanaian Values** 1

**Integrating 21st Century Skills and Competencies** 1

**Balanced Approach to Assessment - not just Final External Examinations** 1

**An Inclusive and Responsive Curriculum** 2

**Social and Emotional Learning** 2

**Philosophy and vision for each subject** 2

**SUMMARY SCOPE AND SEQUENCE** 3

**SECTION 6: PROCESSES OF POULTRY PRODUCTION AND SALE** 4

**Strand: Farming for Jobs and Income** 4

Sub-Strand: Economic Production of Animals 4

*Theme or Focal Area: Resources and Market Needs for Poultry Production.* 6

*Theme or Focal Area: Organising and Producing Poultry Types Common in the Locality for Eggs and Meat* 9

*Theme or Focal Area: Distribution Outlets and Ways of Marketing Poultry Produce and Products* 12

**SECTION 7: TYPES OF LAND TENURE SYSTEMS AND THEIR EFFECTS ON FOOD PRODUCTION** 15

**Strand: Mobilisation of Resources and Networks** 15

Sub-Strand: Land Tenure Systems for Agriculture. 15

*Theme or Focal Area: Types of Customary and Statutory Land Tenure Systems in Ghana* 17

*Theme or Focal Area: Major Challenges in Customary and Statutory Land Tenure Systems* 20

**SECTION 8: IMPORTANCE OF VEGETABLE AND ORNAMENTAL CROPS IN THE LIVELIHOOD OF PRODUCERS, AND METHODS OF TRANSFERRING PRODUCTION TECHNOLOGY** 24

**Strand: Mobilisation of Resources and Networks** 24

Sub-Strand: Support Systems in Agriculture 24

*Theme or Focal Area: Economic Importance of Selected Vegetable Crops and Ornamental Plants to the Farmer and the Nation* 26

*Theme or Focal Area: Transfer of Technology Approaches with Emphasis on Participatory Agricultural Extension Delivery* 29

**SECTION 9: THREATS OF CLIMATE CHANGE AND MITIGATION MEASURES 35**

**Strand: Agriculture and Climate 35**

Sub-Strand: Climate Variability, Adaptation and Mitigation Strategies 35

*Theme or Focal Area: Causes of Climate Change and Current World Disasters* 37

*Theme or Focal Area: Increasing Drought, Pestilence and Decreasing Crop Yields* 40

*Theme or Focal Area: Indigenous Strategies for Dealing with Climate Change and Variability* 42

*Theme or Focal Area: Conventional Responses to Climate Change* 44

*Theme or Focal Area: Effects of Indigenous and Conventional Mitigation Measures for Combating Climate Change on Agricultural Production* 46

**ACKNOWLEDGEMENTS 49**

# INTRODUCTION

The National Council for Curriculum and Assessment (NaCCA) has developed a new Senior High School (SHS), Senior High Technical School (SHTS) and Science, Technology, Engineering and Mathematics (STEM) Curriculum. It 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 Book Two of the Teacher Manual for Agricultural Science covers all aspects of the content, pedagogy, teaching and learning resources and assessment required to effectively teach Year One of the new curriculum. It contains information for the second 11 weeks of Year One. Teachers are therefore to use this Teacher Manual to develop their weekly Learning Plans as required by Ghana Education Service.

Some of the key features of the new curriculum are set out below.

## Learner-Centred Curriculum

The SHS, SHTS, and STEM curriculum places the learner at the center of teaching and learning by building on their existing life experiences, knowledge and understanding. Learners are actively involved in the knowledge-creation process, with the teacher acting as a facilitator. This involves using interactive and practical teaching and learning methods, as well as the learner's environment to make learning exciting and relatable. As an example, the new curriculum focuses on Ghanaian culture, Ghanaian history, and Ghanaian geography so that learners first understand their home and surroundings before extending their knowledge globally.

## Promoting Ghanaian Values

Shared Ghanaian values have been integrated into the curriculum to ensure that all young people understand what it means to be a responsible Ghanaian citizen. These values include truth, integrity, diversity, equity, self-directed learning, self-confidence, adaptability and resourcefulness, leadership and responsible citizenship.

## Integrating 21st Century Skills and Competencies

The SHS, SHTS, and STEM curriculum integrates 21st Century skills and competencies. These are:

- **Foundational Knowledge:** Literacy, Numeracy, Scientific Literacy, Information Communication and Digital Literacy, Financial Literacy and Entrepreneurship, Cultural Identity, Civic Literacy and Global Citizenship
- **Competencies:** Critical Thinking and Problem Solving, Innovation and Creativity, Collaboration and Communication
- **Character Qualities:** Discipline and Integrity, Self-Directed Learning, Self-Confidence, Adaptability and Resourcefulness, Leadership and Responsible Citizenship

## Balanced Approach to Assessment - not just Final External Examinations

The SHS, SHTS, and STEM curriculum promotes a balanced approach to assessment. It encourages varied and differentiated assessments such as project work, practical demonstration, performance assessment, skills-based assessment, class exercises, portfolios as well as end-of-term examinations and final external assessment examinations. Two levels of assessment are used. These are:

- Internal Assessment (30%) – Comprises formative (portfolios, performance and project work) and summative (end-of-term examinations) which will be recorded in a school-based transcript.
- External Assessment (70%) – Comprehensive summative assessment will be conducted by the West African Examinations Council (WAEC) through the WASSCE. The questions posed by WAEC will test critical thinking, communication and problem solving as well as knowledge, understanding and factual recall.

The split of external and internal assessment will remain at 70/30 as is currently the case. However, there will be far greater transparency and quality assurance of the 30% of marks which are school-based. This will be achieved through the introduction of a school-based transcript, setting out all marks which learners achieve from SHS 1 to SHS 3. This transcript will be presented to universities alongside the WASSCE certificate for tertiary admissions.

### An Inclusive and Responsive Curriculum

The SHS, SHTS, and STEM curriculum ensures no learner is left behind, and this is achieved through the following:

- Addressing the needs of all learners, including those requiring additional support or with special needs. The SHS, SHTS, and STEM curriculum includes learners with disabilities by adapting teaching and learning materials into accessible formats through technology and other measures to meet the needs of learners with disabilities.
- Incorporating strategies and measures, such as differentiation and adaptative pedagogies ensuring equitable access to resources and opportunities for all learners.
- Challenging traditional gender, cultural, or social stereotypes and encouraging all learners to achieve their true potential.
- Making provision for the needs of gifted and talented learners in schools.

### Social and Emotional Learning

Social and emotional learning skills have also been integrated into the curriculum to help learners to develop and acquire skills, attitudes, and knowledge essential for understanding and managing their emotions, building healthy relationships and making responsible decisions.

### Philosophy and vision for each subject

Each subject now has its own philosophy and vision, which sets out why the subject is being taught and how it will contribute to national development. The Philosophy and Vision for Agricultural Science is:

**Philosophy**: The next generation of learners of Agriculture can reach their full potential through climate-aware learner-centred pedagogies to develop an interest in agriculture to improve food production.

**Vision:** Learners equipped with 21st Century skills and competencies who are excited about agriculture and create employment and wealth through the application of technology in agriculture.

# SUMMARY SCOPE AND SEQUENCE

| S/N | STRAND | SUB-STRAND | YEAR 1 | | | YEAR 2 | | | YEAR 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CS | LO | LI | CS | LO | LI | CS | LO | LI |
| 1. | New Dawn in Agriculture | Misconceptions and Prospects in Agriculture and Farming | 1 | 2 | 2 | 4 | 4 | 9 | - | - | - |
| | | Emerging Technologies in Agriculture. | 3 | 3 | 7 | 1 | 1 | 2 | 1 | 2 | 2 |
| | | Agricultural Machineries | 2 | 2 | 4 | 1 | 1 | 2 | 1 | 1 | 2 |
| 2. | Farming for jobs and income | Economic Production of Crops | 1 | 1 | 3 | 1 | 1 | 3 | 4 | 4 | 9 |
| | | Economic Production of Animals | 1 | 1 | 3 | 2 | 2 | 5 | 1 | 1 | 3 |
| 3. | Mobilisation of Resources and Networks | Land Tenure Systems for Agriculture. | 1 | 1 | 2 | - | - | - | - | - | - |
| | | Support Systems in Agriculture. | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 |
| 4. | Agriculture and Climate | Climate Variability | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 2 |
| | | Climate Change Adaptation | 1 | 1 | 1 | - | - | - | - | - | - |
| | | Climate Change Mitigation Strategies | 1 | 1 | 1 | - | - | - | 1 | 1 | 1 |
| **Total** | | | **14** | **15** | **27** | **12** | **12** | **25** | **12** | **13** | **21** |

**Overall Totals (SHS 1 – 3)**

| | |
|---|---|
| Content Standards | **38** |
| Learning Outcomes | **39** |
| Learning Indicators | **74** |

# SECTION 6: PROCESSES OF POULTRY PRODUCTION AND SALE

Strand: **Farming for Jobs and Income**

**Sub-Strand:** Economic Production of Animals

**Learning Outcome:** *Explain the key processes involved in poultry production.*

**Content Standard:** Demonstrate knowledge, skills and understanding in the economic production of poultry.

## INTRODUCTION AND SECTION SUMMARY

This section helps learners appreciate the gathering of resources and market needs of consumers to produce poultry and poultry products to improve their income and livelihoods. Many Ghanaians depend on eggs and chicken as a means of providing protein for their family since they are comparatively cheaper than other sources of meat. Hence, introducing learners to the identification of resources and market needs and producing poultry for eggs and meat, will open up a new and lucrative venture for young farmers. The section aims to help learners acquire the prerequisite knowledge and skills needed to plan, organise, produce and market poultry and poultry products successfully. Learners have to do market research to obtain some of the information. The concepts in this section are also covered to some extent in economics and agribusiness studies. Learners will, therefore, be exposed to pedagogical exemplars such as think-pair-share, collaborative learning, talk for learning and exploratory learning. Both formative and summative assessment techniques should be used to promote inclusiveness and cater for the differences in the ability of learners.

The section covers weeks 13, 14 and 15, with the following learning indicators:

**Week 13**: Identify resources and market needs for poultry production.

**Week 14**: Organise and produce a type of poultry that is common in their locality for eggs and meat.

**Week 15**: Identify various distribution outlets and ways of marketing poultry produce and products.

## SUMMARY OF PEDAGOGICAL EXEMPLARS

Pedagogical exemplars such as think-pair-share, collaborative learning, talk for learning and exploratory learning should be used. Learners work in pairs, mixed ability and mixed gender groups (where appropriate), to find information from different sources about the resources and market needs for poultry production. They will find out how to organise and produce poultry for eggs and meat, either by browsing the Internet or visiting people in the community for information and presenting their findings on charts pasted on the walls to conclude. Through these approaches, learners are encouraged to speak during lessons as they discuss the concepts of resource and market needs identification thus improving their communication skills. More confident learners should be assigned additional tasks to allow them to perform leadership roles as peer teachers to support colleague learners. Project work should be executed on the school premises (where possible) to mimic real field experience.

## ASSESSMENT SUMMARY

Assessment strategies that will promote inclusiveness and match any differences in the ability of learners should be deployed in this section. Both formative and summative assessment techniques should be used effectively. While the former should be used during the teaching and learning process to check learners' progress, the latter should be used at the end of the section to measure learners' achievements. Oral and written responses to questions or tasks will enhance their critical thinking and writing skills. Practical work and visits to the community and markets should be assigned to learners to enable them to practise the production and marketing of poultry and its products. Teachers are expected to give prompt feedback on learners' performance and update the transcript system with learners' assessment records.

# Week 13

**Learning Indicator:** *Identify Resources and Market Needs for Poultry Production.*

## Theme or Focal Area: Resources and Market Needs for Poultry Production.

The term resources cover all the required materials including capital, land, tools, equipment and infrastructure. Marketing is the act of buying and selling in a market where consumers get their essential needs. Market needs are things that satisfy the basic requirements of consumers. All the necessary processes of handling poultry and poultry products such as dressing, washing, cleaning, sorting, grading, packaging and ways of marketing poultry and poultry products are done to satisfy these needs. A plan of activities is needed for target groups and how to conveniently provide the goods and services to the consumers and customers of the poultry and poultry products. This includes the identification of the various components and outlets for marketing poultry products. The knowledge and skills of caring for and management of poultry and poultry products are equally relevant since poultry must be raised to maturity before their products such as eggs and meat are obtained.

**Resources required for poultry enterprise establishment**:

1. Capital to finance the project
2. Land to establish the poultry house
3. Poultry house/structure
4. Breeding stock (starter breeds)
5. Feed
6. Vaccine to control disease and pests
7. Feeding and water troughs
8. (Permanent source of) litter
9. Permanent source of water

**Elaboration on some of the resources**

**Land**: Poultry production requires a large area of land for housing, feed storage and waste management.

**Water**: Poultry requires a clean, adequate, and reliable source of water for drinking and sanitation management.

**Feed:** Poultry requires a balanced diet consisting of protein, carbohydrates, vitamins and minerals for optimal growth and good health.

**Medication (Vaccines)**: Poultry requires regular medication and vaccination to prevent and control pests and diseases.

**Equipment**: Poultry production requires various types of equipment such as feeding and water troughs, heating and lighting and ventilation systems, incubators, hatcheries, and stores.

*Picture of a water trough*

*Picture of a feeding trough*

## Market requirements for poultry production

The producer must be conscious of the quality of his/her poultry product, affordable prices and consumer preference and be able to produce a regular supply.

**Factors to consider in marketing poultry and poultry products**

1. **Goal/purpose of production**:
   a. Which system of production to adopt:
      i. extensive system/free range system
      ii. intensive system e.g. battery cage system
      iii. semi-intensive
   b. What to produce – eggs or meat, layers, cockerels or broilers?
   c. What breed to produce – local or exotic breeds?
   d. Target market – local or foreign markets
2. **Market outlets for poultry and poultry products**
   a. Wholesale marketing
   b. Roadside marketing
   c. Farm gate marketing

**Market (Consumer) needs for poultry produce and product marketing**

1. **Quality product**: The market (consumer) demands high-quality poultry products that are free from contaminants, antibiotic residues, pests and disease pathogens.
2. **Affordable pricing**; Consumers look for affordable prices for poultry products that meet their budget.
3. **Convenience**: Consumers want readily available poultry products with easy access to retail stores and markets.
4. **Halal and Kosher Certification**: Some customers prefer halal and kosher-certified poultry products for religious reasons.
5. **Environmental impact**: The market requires that poultry production practices are sustainable, environmentally friendly, minimise pollution and consider the welfare of animals.

**Learning Tasks**

1. Browse the Internet for the factors that drive consumer preferences and trends in the poultry industry.
2. Read the various resources required to establish a successful poultry production venture.
3. Discuss the market needs and demands for poultry production.

## Pedagogical Exemplars

**Think-pair-share:** The teacher leads learners with probing questions to brainstorm the resources, factors and needs for poultry production and share their thoughts with their peers. More confident learners should support their peers.

**Digital learning:** Learners browse the Internet for information about the resources required to set up poultry ventures, and discuss their findings with their peers. The teacher should support learners with appropriate websites and ensure that learners who are more competent at using the internet should help their less competent peers.

**Talk-for-learning:** Learners in the same groups discuss the market needs for profitable poultry production and produce written reports.

## Key Assessments

**Assessment Level 1:** List the resources required for the production of poultry eggs and meat.

**Assessment Level 2:** Explain the market needs for poultry production.

**Assessment Level 3**: Discuss how meeting the market needs for poultry meat and egg production can help make the poultry business a success.

**Assessment Level 4:** Imagine you are planning to start a new poultry production business, discuss the essential resources you would prioritise to build a strong brand and reputation in the market.

# Week 14

**Learning indicator:** *Organise and Produce a Poultry Type that is Common in the Locality for Eggs and Meat.*

## Theme or Focal Area: Organising and Producing Poultry Types Common in the Locality for Eggs and Meat

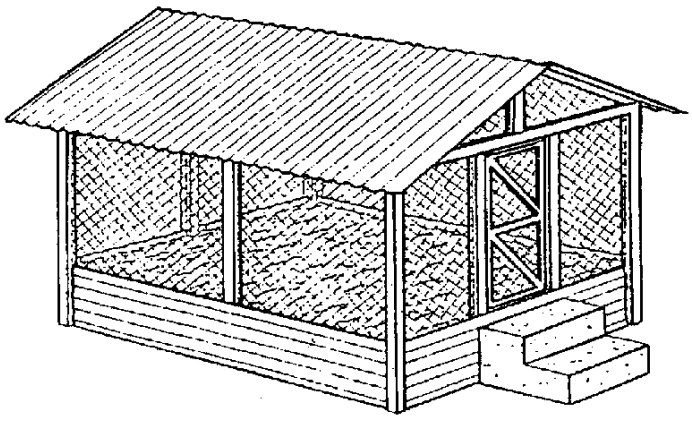
The farmer could be producing either eggs or meat or day-old chicks. Whichever he/she decides will determine the type of resources to put together towards the production. In this lesson, learners are concentrating on egg and meat production.

1. **Resources required to start poultry production**
   a. Income/capital
   b. Land and structure preparation
   c. Feed/rations
   d. Vaccines
   e. Water and feeding troughs
   f. A permanent source of litter

Proper hygiene and effective management practices including vaccinations should be taken into account.

**Organising to produce poultry for eggs and meat**:

1. **Choose poultry type**: Decide on the type of poultry to raise. For egg production, chickens like White Leghorn, Brown Leghorn, Goldline chicken, Rhode Island Red, Light Sussex and Plymouth Rock are popular choices. For meat production, broiler chickens such as Dark Cornish and Marshall Broiler or guinea fowl, turkeys, quails, ducks and ostriches are common options.
2. **Housing and infrastructure**: Construct appropriate housing and infrastructure for the poultry. Ensure it provides adequate space, ventilation, lighting and protection from predators and harsh weather conditions.
3. **Feeding and nutrition**: Develop a good feeding schedule for the poultry, using high-quality feed with essential nutrients, for healthy growth and optimum egg production.
4. **Health care and biosecurity**: Implement a regular health care programme including a vaccination schedule for the well-being of poultry.



*An illustration of a deep litter house. (Copyright: Nick van Eekeren)*

*Poultry in a deep litter house*

5. **Egg production management**: Provide nesting boxes and suitable conditions to encourage egg-laying. Collect eggs regularly to maintain cleanliness and prevent damage.
6. **Meat production management**: For meat production, monitor the growth of the birds and ensure they have access to a balanced diet to reach the desired weight by 8 weeks for broilers and six months for cockerels to maximise profit.
7. **Marketing and distribution**: Develop a marketing plan to sell eggs and meat products. This can involve local markets, grocery stores, restaurants or direct-to-consumer sales.
8. **Record keeping**: Keep detailed records of production data, including egg or meat yield, expenses and health-related information. This information helps in making informed decisions and identifying areas for improvement. These records can be kept in portfolios or field notebooks.
9. **Compliance and regulations**: Ensure that all local regulations and standards related to poultry farming, including animal welfare and food safety guidelines are met.
10. **Continuous improvement**: Regularly assess and improve your poultry management practices to optimise productivity, quality and efficiency.
11. **Peer consultation:** Consult with experienced poultry farmers or agricultural experts since they can provide valuable insights to help with the success of the venture.
12. **Egg laying and incubation for day-old chick production**: In case you plan to breed poultry, select a healthy breeding stock with desirable traits for egg-laying or meat production. Proper breeding management will ensure a productive and robust flock. It is necessary to place cockerels with the layers/hens in the pens with 1 cockerel to 15 hens. This will ensure the production of fertile eggs for incubation either by natural or artificial means. The period taken for the egg to hatch is referred to as the incubation period. Natural means broody hens sit on their eggs to hatch them. For artificial means, eggs are placed in an incubator, where they hatch after 20 - 21 days for chicken, 28 days for duck, guinea fowl and turkey, and 42 days for ostrich.

**Learning Tasks**

1. List the stages and challenges involved in poultry production.
2. Develop questionnaires to obtain information on the criteria used to identify potential suppliers and partners for poultry production.
3. Develop a resource and market needs plan for poultry production.

## Pedagogical Exemplars

**Enquiry-based learning:** Learners, in groups, visit a nearby poultry farm to observe the various stages in the production of poultry eggs and meat. The teacher should help learners develop questionnaires to collect data on production resources, production stages and other activities involved. The teacher should encourage all learners to participate.

**Experiential learning:** Where poultry farms are not within reach, learners should watch short documentaries, videos or pictures of poultry production and discuss the stages involved and the challenges in poultry production. Learners with visual or hearing challenges should be provided with appropriate support.

**Talk for learning:** After the field visit or watching the documentaries, learners should develop a comprehensive plan with the information obtained that outlines the required resources for poultry production and addresses the identified market needs. The plan should include strategies for resource acquisition, production processes, distribution channels, markets and sales. The teacher should encourage all learners to participate.

## Key Assessments

**Assessments Level 1:** Outline the stages involved in poultry production.

**Assessments Level 2:** Describe the stages involved in poultry production.

**Assessments Level 3:** Discuss the challenges and solutions in poultry production.

**Assessments Level 4:** Prepare a portfolio of the processes of layer poultry production.

# Week 15

**Learning Indicator:** *Outline Various Distribution Outlets and Ways of Marketing Poultry Produce and Products.*

## Theme or Focal Area: Distribution Outlets and Ways of Marketing Poultry Produce and Products

The knowledge of market or consumer demands, target populations, packaging and means of delivering goods and services is of great importance for the successful marketing of one's products. The types of marketing outlets must be analysed before the start of production.

### Types of marketing outlets:

1. **Local farmer markets:** These are stalls set up at farms, also called farm gate markets, to directly sell to consumers looking for fresh eggs and meat products.
2. **Grocery stores and supermarkets:** Local grocery stores and supermarkets that distribute poultry products to a wider customer base.
3. **Restaurants, eateries and hotels:** These take up poultry products regularly to support their menu.
4. **Online sales platforms:** These are e-commerce platforms for selling poultry products and offer doorstep deliveries.
5. **Community Supported Agriculture (CSA):** This is a community programme that brings farmers together to supply their produce to meet expected volumes required by the community, but also supplies to consumers located outside the community. However, consumers must subscribe to receive regular supplies.
6. **Foodservice distributors:** Foodservice distributors link producers to institutions such as schools, hospitals, and catering businesses.
7. **Local butcher shops:** These shops specialise in selling meat products.
8. **Specialty stores:** These are distribution outlets that focus on organic products and may be interested in keeping poultry products hygienically produced.
9. **Wholesales:** Wholesale distributors purchase poultry products directly from poultry farmers and sell them to supermarkets retailers and restaurants.
10. **International markets:** Poultry products are exported to foreign countries where demands for such products are high.

**Ways of reaching outlets marketing poultry produce and products**:

Marketing is an ongoing process and it is essential to adopt strategies based on customer feedback, market trends and changing consumer preferences. It is important to be consistent in providing high-quality products and excellent customer service to build a loyal customer base. Ways of doing this include:

1. **Online presence:** Create a website or social media profile to showcase your poultry products, share your farming practices and engage with potential customers.
2. **Social media marketing:** Use social media platforms to reach a wider audience and share interesting content such as recipes, cooking tips and behind-the-scenes glimpses of your farm.
3. **Email marketing:** Build an email list and send out regular newsletters with updates, promotions, and exclusive offers.

4. **Farm events and workshops:** Host farm events, workshops or open houses to educate the community about your poultry farming practices and build brand awareness.
5. **Collaborations and partnerships:** Partner with local chefs, nutritionists or influencers who can promote the products and provide recipe ideas.
6. **Sampling and tastings:** Offer samples of your poultry products at farmers' markets or food festivals to attract potential customers.
7. **Testimonials and reviews:** Encourage satisfied customers to leave reviews and testimonials that can build trust and credibility for your products.
8. **Community engagement:** Get involved in community events and initiatives to connect with local consumers and showcase your commitment to sustainable and ethical farming.

To remain competitive, product labelling and packaging should be of good quality. The design should be attractive and informative, highlighting the quality, source and any certifications (eg organic, free-range) to appeal to consumers.

**Learning Tasks**

1. Learners read about the distribution outlets for poultry products.
2. Explain how the distribution outlets are important for poultry production.
3. Discuss the needs and demand for poultry meat, eggs and products.
4. Download and study the Market Analysis and Forecasting App from the Internet.

## Pedagogical Exemplars

**Managing talk for learning:** Learners in groups discuss the distribution outlets, their importance and how to create or identify the needs and demand for eggs, meat and products. Learners should be helped with probing questions that will help them list the distribution outlets for poultry production. More confident learners should explain how these outlets are important for poultry production.

**Talk for learning:** Learners in their groups discuss how to access the various poultry distribution outlets in the community as well as those found on the Internet and discuss ways of marketing the poultry produce. More confident learners should be encouraged to lead the groups.

**Digital learning:** The teacher guides learners to download the Market Analysis and Forecasting App from the Internet and uses probing questions to help them understand how to use it. Learners who are more confident in using the Internet should lead the various groups and support other learners.

**Exploratory learning:** In groups, learners carry out research on the range of poultry outlets in the community and ways of marketing poultry produce e.g. live bird retailers, eateries, restaurants, hotels, supermarkets and event organisers. Consider how best to market poultry produce including using browsers and social media. The teacher should encourage peer facilitation.

## Key Assessments

**Assessment Level 1:** Identify market distribution outlets for poultry eggs and meat.

**Assessment Level 2:** Outline ways of marketing poultry eggs and meat.

**Assessment Level 3:** Explain the processes used to process poultry for the market and describe how this will improve the shelf-life of the product.

**Assessment Level 4:** Design a questionnaire on consumer preferences, market trends, competition, and pricing for poultry meats and eggs.

## Section 6 Review

This section helped learners identify resources required for the production of poultry, including the choice of poultry to produce, housing and feeding, control and management of poultry pests and diseases, types of market outlets, the need for quality products, market chains, packaging and pricing to meet consumer demands and budget. The pedagogical exemplars used in this section enabled learners to develop manipulative, collaborative, critical thinking and problem-solving skills. The various assessment strategies such as oral presentation, essay prompts and demonstration of skills learnt were designed to include all four levels of assessment.

### References

1. STEM Agricultural Science Curriculum
2. STEM Agricultural Science Curriculum

# SECTION 7: TYPES OF LAND TENURE SYSTEMS AND THEIR EFFECTS ON FOOD PRODUCTION

Strand: **Mobilisation of Resources and Networks**

**Sub-Strand:** Land Tenure Systems for Agriculture.

**Learning Outcome:***Explain the different types of land tenure systems.*

**Content Standard:** Demonstrate knowledge and understanding of the different types of land tenure systems for agricultural production.

## INTRODUCTION AND SECTION SUMMARY

Land acquisition and ownership have been a major problem for agricultural production in Ghana, especially in the peri-urban areas where the demand, particularly for agricultural land, has been quite high. Hence any available land is offered at exorbitant prices and may also be subject to multiple sales. Young potential farmers should, therefore, be knowledgeable about the various types of land tenure systems before embarking on any agricultural venture, be it on a small or large scale. This section explains the various types of land tenure systems and the inherent disadvantages or challenges thus helping young farmers know what will be in their best interests. The content standard of land tenure systems is also taught in Geography.

The section covers weeks 16 and 17, with the following learning indicators:

**Week 16:** Various types of customary and statutory land tenure systems

**Week 17:** Major challenges in customary and statutory land tenure systems**.**

## SUMMARY OF PEDAGOGICAL EXEMPLARS

The teacher has to provide enough background information to allow learners to contribute through informed and meaningful discussion. Therefore, teachers need to explain the various land tenure systems to learners, such as (i) Customary or traditional or communal land tenure, (ii) Leasehold land tenure, (iii) Freehold title system, (iv) Individual land tenure and (v) Statutory land tenure systems to the young learners. Pedagogies such as talk for learning, collaborative learning and enquiry-based learning should be adopted to facilitate the learning process.

Enquiry-based learning should be used where learners go to the local community to find out from the elders the predominant land tenure systems practised and their benefits and demerits. Extra reading assignments on gender disparities in land acquisition and their effects on food production should be further explored to provide additional challenges for specific learners.

## ASSESSMENT SUMMARY

The assessment strategy for this section will allow teachers to adequately and fairly assess the variations in learners' ability and the expected depth of knowledge of learners. The assessment approach focuses more on formative assessment, promoting continuous improvement and all-inclusive learner development. The assessment tools to be deployed by teachers should include individual oral and written responses to questions to allow learners to develop or enhance communication and composition skills.

Group presentations in plenary sessions should enable learners to think and communicate their ideas and findings thus improving their communication skills and critical thinking. The performance of

learners in the assessment should be part of the continuous assessment process and recorded in the transcript system. Prompt feedback should be given to learners on their performance and additional support should be provided wherever necessary.

# Week 16

**Learning Indicator:** *Describe Various Types of Customary and Statutory Land Tenure Systems.*

## Theme or Focal Area: Types of Customary and Statutory Land Tenure Systems in Ghana

Land tenure is described as the system of rights and obligations governing the acquisition, holding and disposal of lands by law or convention.

**Types of land tenure systems:**

a. **Customary/traditional/communal land tenure:** It refers to a traditional form of land ownership and management that is deeply rooted in the customs (cultural norms), beliefs, practices and unwritten laws of a specific community or indigenous group, passed down through generations. Under this system, land is not regarded as a negotiable possession. Such systems exist where land is plentiful and has little or no monetary value.

   i. **Ownership and Control**: Land is often owned collectively by the community or a specific clan. Individual members of the community have customary rights to use the land for agricultural purposes or housing. These rights are typically not formalised through legal documentation.

   ii. **Transfer and Inheritance**: Inheritance and transfer of land usually follow customary rules, where land is passed down to the succeeding generations within the community or clan.

   iii. **Land management under the traditional tenure system**: Traditional leaders or elders play a significant role in managing and resolving land-related disputes within the community.

   **Summary of characteristics of communal land tenure system:**

   - Land is owned by the entire community or belongs to family members.
   - Sale of land is rare as it is usually not permitted.
   - The procedure for a non-member or stranger to a community to acquire such lands is frustrating and time-consuming.
   - Land under the traditional tenure system cannot be used as collateral security, for example, to obtain loans from financial institutions
   - The customs and beliefs in the community may affect the use of these lands. For example, taboos and belief systems associated with the communal system may affect its use for modern agricultural purposes.

b. **Statutory land tenure system:** This land tenure system is based on legally established laws and regulations implemented by the government or state authority. It involves the formal recognition of individual or institutional land ownership, with defined property rights and legally enforceable land-use agreements, and land is treated as private property with clear ownership titles.

   i. **Ownership and control**: Under statutory systems, land can be privately owned by individuals, corporations or the state. Ownership is usually formalised through legal titles and land registration.

   ii. **Transfer and inheritance**: Land transactions and transfers are recorded and legally recognised. Ownership can be transferred through sale, lease or inheritance, following the legal procedures prescribed by the government.

   iii. **Management of the land**: Statutory land tenure systems are often managed by government agencies responsible for land administration and registration.

**Summary of characteristics of statutory land tenure system**.

- Land is owned by an individual who has acquired it through purchase or inheritance.
- Sale of land is common if an individual owner prefers to do that.
- Land can be sold to any individual irrespective of their background.
- Such land can be used as collateral to obtain a loan.
- Statutorily acquired lands can be used for any agricultural project.

c. **Freehold title system / Individual land tenure system**: Freehold land tenure system grants the holder absolute ownership rights over the land, without any time limitation or obligations to the state or other entities. This type of land tenure system gives nearly complete ownership of land and its resources to a new person to use for a specified period. Absolute title can be passed over from the owner to his/her heirs.

i. **Ownership and control**: The landowner has complete control and may, subject to compliance with relevant laws, use, sell or transfer the land without restrictions.

ii. **Transfer and inheritance**: The land can be transferred to or inherited by the landowner's choice, following legal procedures.

**Summary of characteristics of the freehold land tenure system:**

- Land can be purchased outright from the original owners.
- Land may also be given out as a gift by land-owning communities, especially in areas where the demand for land is not very great.
- Chiefs and elders of a community may also give out land on a long-term arrangement to either government or individuals for specific agricultural or other development projects e.g. the establishment of forest reserves by the government in a particular community.
- Legally acquired freehold lands are very secure.
- The freedom associated with freehold titles may lead to abuse of such lands with unauthorised projects.

d. **Leasehold tenure system**: In this land tenure system, individuals or entities hold the right to use and occupy the land for a specified period, typically through a lease agreement with the landowner or government.

i. **Ownership and control**: The land remains the property of the leaser (landowner or government), while the lessee has rights to use and or exploit the land within the terms of the lease.

ii. **Transfer and inheritance**: Leasehold rights can be transferred or inherited based on the terms stipulated in the lease agreement or applicable laws.

**Summary of characteristics of leasehold land tenure system**:

- Land is acquired for use over a fixed/stated period or under agreed specified conditions.
- The period is usually more than 25 years, but it is possible to have a shorter lease period e.g. 1-5 years during which an annual fee or rent may be paid.
- The agreement may or may not be renewed when the period of the lease contract lapses.
- Certain rent or fees are paid for the stated period.
- The lessee cannot use the land as collateral security.
- The lessee cannot develop land beyond the lease agreement terms.
- The leaser has the legitimate right to take back the land if the lessee fails to use the land at all or fails to use it for the agreed project.

- Depending on the lease period, long-term investment may be done on such lands. The rent paid on leased land is usually dependent on the location of the land, the owner of the land, the purpose for leasing and the number of years to be leased out.

**Learning Tasks**

1. Learners search for information on the various types of land tenure systems.
2. Learners discuss the advantages and disadvantages of the various types of land tenure systems and their impacts on food production.
3. Examine how land tenure systems may create gender disparities in land acquisition and ownership.

## Pedagogical Exemplars

**Talk for learning:** The teacher initiates a talk for learning by providing background information on the various types of land tenure. This should help learners to have informed discussions about the different land tenure systems. The teacher should provide help to some learners by asking probing questions thus allowing them to contribute meaningfully to the learning process.

**Enquiry-based learning:** Learners in groups carry out internet searches to identify the characteristics of the various land tenure systems. Learners requiring greater challenge should be encouraged to seek information on issues related to land inherited through maternal and paternal lineages and share the outcomes with the class.

**Collaborative learning:** In the same groups, learners should discuss the merits and demerits of the different forms of land tenure systems, and present findings to the class orally or in writing, as appropriate.

## Key Assessments

**Assessment Level 1**: List the four types of land tenure systems.

**Assessment Level 2**: Explain the importance of land acquisition to food crop production.

**Assessment Level 3**: Compare the customary land tenure system with the statutory land tenure system.

**Assessment Level 4**: Evaluate the potential impacts of implementing a statutory land tenure system in a region with diverse customary practices.

# Week 17

**Learning Indicator:** *Determine The Major Challenges in Customary and Statutory Land Tenure Systems.*

## Theme or Focal Area: Major Challenges in Customary and Statutory Land Tenure Systems

Both customary and statutory land tenure systems of land acquisition have their peculiar limitations. The major challenges inherent in the two types of land tenure systems are explained below.

**Challenges in customary land tenure systems**:

1. **No formal documentation:** Customary land tenure is often based on verbal and unwritten narrations, handed down by older generations and, therefore not supported or covered by a written or formal document. This results in disputes over land boundaries and ownership, with time.
2. **Insecure land rights:** Due to the lack of formal documentation and legal recognition, customary land tenure systems usually lead to insecure land rights for individuals and communities. This results in conflicts and displacement through land grabbing and encroachment by more powerful individuals.
3. **Gender inequality:** In many customary systems, women often face discrimination in land ownership and inheritance, leading to limited or no access to land ownership and control. Such discrimination perpetuates gender disparities in rural communities that limit women's economic empowerment in agriculture and related activities.
4. **Limited access to credit and investments:** Without formal land titles, individuals may find it challenging to access credit or invest in agricultural activities.
5. **Forced evictions and the loss of ancestral lands for modernisation and urbanisation:** Rapid urbanisation and infrastructure development can put pressure on customary lands, leading to the loss of agricultural land for other purposes.
6. **Inadequate compensation for customary lands taken for development projects:** Customary land can be subject to government-led land acquisition for developmental projects, often without the consent of affected communities. Hence land owners get poor compensation.
7. **Environmental degradation:** The absence of clear land ownership rights in customary systems can contribute to environmental degradation, as land is exploited without proper management and conservation practices.

**Challenges in statutory land tenure systems**

1. **Land concentration:** In statutory systems, private ownership can lead to land concentration in the hands of a few individuals, resulting in landlessness and inequality among rural populations.
2. **Land disputes and overlapping claims:** Statutory land tenure systems may not always have clear and accurate land records, leading to disputes over land boundaries and conflicting claims to ownership.
3. **Land speculation and land grabs:** Weak land governance and regulations in statutory systems especially in areas of high land demand can lead to land grabbing and speculative practices by powerful individuals or corporations, resulting in the displacement of local communities.45.
   **Lack of fairness and transparency of land transactions:** Corruption within land administration agencies can undermine easy land entitlement, making it difficult for ordinary citizens to access land and property rights.

7. **Inefficiencies in land administration:** Inadequate legal frameworks or weak land governance and unclear land laws can lead to corruption in land administration, affecting land tenure security.
8. **High administrative costs:** The process of land registration and obtaining formal titles can be complex, time-consuming, and expensive for individuals, especially in rural communities.
9. **Overlapping jurisdiction:** In some cases, statutory land tenure systems may overlap with customary systems, leading to confusion and conflicting land claims.
10. **Poor land management practices:** Poor land management practices and rapid land use change, often associated with individual ownership, can lead to land degradation and environmental challenges.

**Disadvantages of communal system of land tenure**

1. Land can never be used as a security to obtain loans from financial institutions.
2. Members can only be allotted a small area of the land to farm causing excessive land fragmentation, resulting in several small land holdings, unsuitable for large-scale production.
3. Land owners generally feel that it is immoral to sell land since it robs future generations of the opportunity to inherit it.
4. Cultivation of cash crops or permanent tree crops is difficult and at times prohibited.
5. Land is rarely improved since there is no sense of security for its use.
6. Taboos and belief systems associated with the communal system may affect its use for modern agricultural purposes.
7. Mortgage in the traditional system could lead to litigation, especially when the agreement is made without representation from certain lineages of the family.

**Disadvantages of leasehold system for short leases and where annual rents are paid**

1. The leaseholder might be restricted by the terms of the contract from growing certain crops e.g. tree crops.
2. In some areas, land acquisition may be expensive and rents may be too high beyond the ability of many young or rural farmers.
3. Such lands cannot be used as collateral security.

**Disadvantages of land tenure by inheritance**

1. Land tenure by inheritance is characterised by excessive land fragmentation, as family and clan sizes increase.
2. Sharing of land often generates bitter enmity among family members.
3. Individual rights to parcels of land are sometimes difficult to determine.
4. Land can remain unused over a long period under fallow as that piece of land remains the property of whoever made it fallow.
5. Although the sale of land is possible, the sale of inherited land must have the consent of every member of the family.
6. Owners of inherited lands feel it is immoral to sell land since it robs future generations of the opportunity of land acquisition.

**Learning Tasks**

1. Learners discuss the main challenges inherent in the various land tenure systems.
2. Learners discuss the disadvantages commonly faced in land tenure systems, such as the communal land tenure system.
3. Conduct interviews in the local community, where possible, on land tenure systems and the challenges therein.

## Pedagogical Exemplars

**Talk for learning:** Learners in groups discuss the challenges in customary and statutory land tenure systems and present their findings in a plenary session. The teacher should support learners as necessary with probing questions to enable them to identify and discuss the challenges associated with the customary land tenure system.

**Digital learning:** Learners in groups search the Internet and other sources for information on the challenges to land acquisition and tenure. Learners who are more proficient at using the Internet should assist other learners who may have difficulty accessing the information.

**Enquiry-based learning:** The teacher should lead learners in groups into the community to interview the elders on the challenges in land acquisition and tenure. Learners should record their findings in their field notebooks for later discussion.

## Key Assessments

**Assessment Level 1**: List challenges in customary and statutory land tenure systems.

**Assessment Level 2**: Explain the disadvantages of communal land tenure systems.

**Assessment Level 3**: Examine the legal and customary arrangements for addressing land tenure conflicts.

**Assessment Level 4:** Analyse the impact of insecure land rights on communities dominated by customary land tenure systems.

# Section 7 Review

This section deals with the various types of land tenure systems and the major challenges in acquiring land for any agricultural project. It should be made clear to learners that land is not there as a free resource since it is owned by someone and the land can only be acquired through inheritance or legally. The various disadvantages should be presented about each tenure system so that learners who may decide on agriculture as a business and therefore might need a large parcel of land, do not fall prey to any unscrupulous individuals in the community. With the knowledge acquired about the challenges in land acquisition and ownership, conflicts and unnecessary litigation would be reduced and thereby agricultural productivity would be enhanced.

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# SECTION 8: IMPORTANCE OF VEGETABLE AND ORNAMENTAL CROPS IN THE LIVELIHOOD OF PRODUCERS, AND METHODS OF TRANSFERRING PRODUCTION TECHNOLOGY

Strand: **Mobilisation of Resources and Networks**

**Sub-Strand:** Support Systems in Agriculture

**Learning Outcomes:**

1. *Explain the different types of support systems in vegetable and ornamental crop production and marketing.*
2. *Evaluate extension services delivery on vegetable and ornamental crop enterprises.*

**Content Standard:**

1. Demonstrate knowledge and understanding of the different types of support systems in vegetable and ornamental crop production and marketing.
2. Demonstrate knowledge and understanding of the approaches and methods of agricultural extension delivery.

## INTRODUCTION AND SECTION SUMMARY

This section is designed to introduce learners to the mobilisation of resources and networks for agricultural production. Learners need to have in-depth knowledge of the economic importance of selected vegetable crops and ornamental plants to the livelihood of producers and the broader value chain. Learners are also required to have a deep understanding of technology transfer approaches and the methods involved in agricultural production. Agriculture has evolved from subsistent activity to modern commercial enterprise, therefore, it is important to fully equip learners with knowledge about the economic benefits of engaging in any agricultural production enterprise. This should motivate learners to appreciate the need to take up agricultural production as a profession after the completion of their education.

Commercial agricultural production cannot thrive without adequate technological backing, hence the need to prepare learners to appreciate the benefits of technology transfer in agricultural production**.** The main pedagogical approaches employed in this section include thinking pair-share, digital learning, enquiry-based learning and structured talk for learning. The assessment is mainly formative, which promotes continuous improvement and gets all learners involved in the teaching and learning activities. The concept of resource mobilisation and networking for agricultural production is also taught in economics.

The weeks covered in the section are Weeks 18 and 19, with the following learning indicators:

**Week 18:** Describe the economic importance of selected vegetable crops and ornamental plants in the livelihood of the producers and the broader value chain.

**Week 19:** Describe technology transfer methods with emphasis on participatory approaches.

## SUMMARY OF PEDAGOGICAL EXEMPLARS

The concepts to be learnt under this section require the use of pedagogical strategies such as think-pair-share, digital learning, enquiry-based learning and structured talk for learning**.** Think pair-share should be used to guide learners to examine the economic importance of vegetable crops and ornamental plants. Digital learning should be deployed for the participatory extension service delivery as well as for the economic importance and impact of vegetable crops and ornamental plants on the farmer and the nation. Enquiry-based learning should be used when learners visit and interview producers and vendors of selected vegetable crops and ornamental plants. They should focus on the economic benefits they derive from participating in the production, marketing and exporting of these crops. Structured talk for learning should be used when discussing technology transfer and its contribution to agricultural production. To foster collaboration and peer teaching among learners, teachers should deploy mixed-ability and mixed-gender groupings (where appropriate) when carrying out any learning task. Teachers should provide support for all learners, whether to aid understanding or to provide additional challenges.

## ASSESSMENT SUMMARY

The assessment strategy for this section allows teachers to use assessment tools that are fair and take into consideration the differences in learners' abilities. The assessment approach focuses more on formative assessment, promoting continuous improvement and should get all learners involved in the teaching and learning activities. The assessment tools to be deployed include oral and written individual and group responses. Such responses will allow learners to think, and communicate their ideas and findings, hence improving their communication and critical thinking skills. Written responses to questions or tasks will help learners form and organise their thoughts to enable them to develop an orderly presentation of ideas and also enhance their writing skills. Learners' performance in the assessment activities should be part of the continuous assessment process and recorded in the transcript system. Prompt feedback should be given to learners on their performance, and additional support should be provided wherever deemed necessary.

# Week 18

**Learning Indicator:** *Describe the Economic Importance of Selected Vegetable Crops and Ornamental Plants to the Livelihood of Producers and the Broader Value Chain.*

## Theme or Focal Area: Economic Importance of Selected Vegetable Crops and Ornamental Plants to the Farmer and the Nation

The economic importance of vegetable crops and ornamental plants is closely linked to the processes from production to consumption (value chain) therefore, it is necessary to introduce the concept of value chain and its importance in agricultural production.

### What is a value chain?

Value chains encompass the full range of activities and services required to bring a product or service from conception to sale and consumption.

The value chain approach in any agricultural enterprise deals with the interrelatedness of actors in the enterprise who add value to products and services as they pass from one link in the chain to the next.

Actors are connected along a chain producing, transforming and bringing goods and services to end-consumers through a sequenced set of activities. Value chains include input suppliers, producers, processors, and buyers, as well as the support services and enabling environments that form a dynamic market system.

**Why a value chain approach?**

1. Value chains develop interventions focused on improving business operations at the level of producers, processors and other actors in the chain.
2. Value chains promote the flow of information and innovation among the actors along the chain.
3. Value chain development can also foster coordination along the chain and reduce entry barriers to international markets.
4. Value addition may create a new commodity or product and make an agricultural product more valuable.

**Economic importance of vegetables and ornamental plants to the farmer**

1. **Employment:** The producers, wholesalers and retailers of vegetables and ornamental plants do this as a full-time job. As well as producing vegetables and ornamental plants, there are job opportunities in providing tools and accessories such as seeds and planting materials, pots, fertilisers, pesticides, and herbicides. Job opportunities are also created in the export industry through the production, processing and marketing of the produce and associated products.
2. **As sources of food and nutrition:** Vegetables form an essential part of main dishes and are good sources of proteins, minerals and vitamins that promote healthy growth and development of both humans and other animals.
3. **Income generation:** Both vegetable crops and ornamental plants can be lucrative sources of income for producers. Vegetable crops are in high demand for consumption, whether sold fresh, processed, or as value-added products such as salads or canned goods. Ornamental plants, on the other hand, are sought after for landscaping, decoration, and gifting purposes. Producers can capitalise on this demand by cultivating and selling these plants for profit.
4. **Crop diversification and risk management:** Growing a variety of vegetable crops and ornamental plants allows producers to diversify their income streams and reduce dependency

on a single crop or market. This diversification strategy helps mitigate risks associated with factors like market fluctuations, pests, diseases, and adverse weather conditions. For example, if one crop fails due to unfavourable conditions, producers can rely on income generated from other crops.

5. **Closing the hunger and income gap**: Vegetable crops and ornamental plants often have different growing seasons, providing producers with year-round income opportunities. By planting a mix of seasonal crops and plants, producers can optimise their production schedules to meet market demand and maximise profits throughout the year. Additionally, some ornamental plants, such as those used for holiday decorations, experience seasonal spikes in demand, creating opportunities for increased sales and revenue during specific times of the year.
6. **Export opportunities**: Vegetable crops and ornamental plants are often traded internationally, presenting producers with opportunities to access lucrative export markets. Producers can leverage their expertise in cultivating high-quality crops and plants to tap into foreign markets and expand their customer base beyond domestic borders. Exporting also diversifies revenue streams and enhances the resilience of producers to fluctuations in local markets.
7. **Environmental benefits:** Both vegetable crops and ornamental plants contribute to environmental sustainability and ecosystem health. They enhance biodiversity, beautify landscapes, and improve air quality. Producers can capitalise on the growing demand for sustainably produced crops and plants by adopting eco-friendly farming practices and promoting their products as environmentally conscious choices.
8. **Medicinal benefits:** Some ornamental plants are used in folk medicine for the treatment of ailments.

**Economic importance of selected vegetable crops and ornamental plants to the nation**

1. **Provision of raw materials to feed processing industries**: Industries process vegetables and fruits into tins, cans and bottles to help preserve and extend their shelf life.
2. **Job creation:** The cultivation, harvesting, processing, and distribution of vegetable crops and ornamental plants create employment opportunities across the agricultural sector. From farm labourers to agricultural scientists, workers are employed in various stages of production, contributing to rural and urban employment. Additionally, there are employment opportunities in related sectors such as transportation, packaging, marketing and retail.
3. **Development and expansion of agricultural manufacturing industries.** These are industries that manufacture inputs for agricultural production such as tools, machines, seeds, fertilisers, pesticides and other equipment.
4. **Revenue generation**: Vegetable crops and ornamental plants contribute significantly to agricultural revenue and overall gross domestic product (GDP). Both sectors generate income through domestic sales, exports and value-added products. By cultivating and selling these crops and ornamental plants, farmers and horticulturists contribute to the national economy by generating revenue streams.
5. **Trade balance:** Exporting vegetable crops and ornamental plants can positively impact a country's trade balance by generating foreign exchange earnings. Countries with favourable climates and expertise in growing specific crops and plants can capitalise on international demand and establish themselves as key exporters in the global market. This not only boosts export revenues but also strengthens the country's position in international trade.
6. **Tourism and aesthetics:** Ornamental plants contribute to the aesthetics of a country, enhancing landscapes, public spaces and tourist sites. Well-maintained gardens, parks and botanical gardens featuring ornamental plants attract visitors, boosting tourism revenues and supporting local economies.

6. **Food security and nutrition**: Vegetable crops play a crucial role in ensuring food security and nutrition within a country. They provide essential vitamins, minerals and dietary fibre necessary for a healthy diet. By promoting the cultivation and consumption of diverse vegetable crops, governments can improve public health outcomes, reduce malnutrition and enhance food security for vulnerable populations.
8. **Environmental benefits**: Ornamental plants contribute to environmental and ecosystem sustainability. They contribute to urban greening, air purification and noise abatement.
9. **Cultural and social significance**: Vegetable crops and ornamental plants hold cultural and social significance within a country, representing traditions, customs, and cultural heritage. They are used in religious ceremonies, festivals, celebrations and rituals, fostering a sense of community and identity.

**Learning Tasks**

1. Map the value chain for a selected vegetable crop or an ornamental plant from production to consumption.
2. Discuss the economic importance of selected vegetable crops and ornamental plants to the country.
3. Evaluate the economic impact of selected vegetable crops and ornamental plants on the farmer and nation.

## Pedagogical Exemplars

**Think-pair-share:** Learners examine the economic importance of vegetable crops and ornamental plants and share their thoughts with other groups.

**Digital learning:** Learners browse the Internet for information on the economic importance and impact of vegetable crops and ornamental plants on the farmer and nation and discuss their findings with their peers. The teacher should help learners identify the importance and impact of vegetable crops and ornamental plants to society. The teacher should monitor and guide learners when they are using the Internet.

**Enquiry-based learning:** The teacher guides learners in their groups to visit producers and vendors of selected vegetable crops and ornamental plants to interview them about their roles and economic benefits. Teachers should support learners who may be having difficulty in carrying out this task.

## Key Assessments

**Assessment Level 1:** State the roles of ornamental plants in environmental health.

**Assessment Level 2:** Discuss the economic importance of vegetable crops and ornamental plants to the farmer.

**Assessment Level 3**: Evaluate the impact of vegetable crop and ornamental plant production on the national economy.

**Assessment Level 4**: Analyse the impact of pepper production on the economy of Ghana.

# Week 19

**Learning Indicator:** *Describe Technology Transfer Methods with Emphasis on Participatory Approaches.*

## Theme or Focal Area: Transfer of Technology Approaches with Emphasis on Participatory Agricultural Extension Delivery

### Definitions/Introduction

Agricultural extension is an out-of-school activity in which adults and young people learn by doing. It is a partnership between the government, extension workers and the people who provide services and education designed to meet the production needs of the people. Agricultural extension is the transfer of scientific research and new knowledge to farmers. The field of agricultural extension now encompasses a wider range of communication and learning activities organised for producers by professionals from different disciplines, including agriculture, agricultural marketing, health and business studies.

#### Types of Agricultural Extension Systems

Agricultural extension delivery can be classified into four main systems based on the source of funding:

1. **Public extension system**: Funded by ministries and departments of agriculture and agricultural research centres.
2. **Private extension system**: Provided by private extension agents such as input manufacturers or distributors and private consulting enterprises.
3. **Non-profit sector system**: Financed by local, provincial, national or international non-governmental organisations such as foundations, commodity groups and other non-commercial associations.
4. **Cost-sharing system**: The cost of agricultural extension is shared between the clients (local farmers or producers) and the other stakeholder groups, namely the public sector.

#### Importance of agricultural extension

1. Capabilities among farmers are developed to enable them to understand their problems and how best to resolve them.
2. It helps to make scientific methods available to the producers so that they can raise their production and standard of living.
3. It helps in community development. Extension education plays a major role in bringing desirable change to producer groups which facilitates community development.
4. It helps to improve productivity. It equips farmers with the necessary knowledge and skills to enable them to produce more efficiently, resulting in increased productivity.
5. It enables farmers to use their production resources efficiently leading to profit maximisation.

### Technology transfer in agricultural extension delivery

Technology transfer in agricultural extension delivery refers to the process of disseminating knowledge, innovations and best practices from research institutions, agricultural experts, and technology developers to farmers and other stakeholders in the agricultural sector. It involves transferring technological advancements, scientific discoveries, and practical solutions to address agricultural challenges and improve productivity, sustainability and livelihoods.

**Key components of technology transfer in agricultural extension delivery:**

1. **Identification of technologies**: Agricultural extension agents and experts identify relevant technologies, practices and innovations that have the potential to benefit farmers and address specific agricultural challenges. These technologies may include improved crop varieties, pest management strategies, irrigation techniques, mechanisation solutions, and post-harvest technologies.
2. **Adaptation and customisation**: Technologies may be adopted as first presented. However, since farmers' agroecological zones and conditions and crops grown usually differ, there is the need to adapt and customise technologies to suit local agroecological conditions, farming systems and socio-economic contexts.
3. **Capacity building**: Agricultural extension programs focus on building the capacity of farmers, extension agents and other stakeholders to understand, adopt and utilise new technologies effectively.
4. **Demonstration and learning:** Technology transfer often involves the organisation of field demonstrations, technology showcases, and farmer-to-farmer information exchange to showcase the benefits and outcomes of adopting new technologies. Farmers have the opportunity to observe, interact with and learn from successful demonstrations, building their confidence and motivation to adopt innovative practices.
5. **Extension services**: Agricultural extension services play a crucial role in facilitating technology transfer by providing advisory support, technical assistance and information dissemination to farmers. Extension agents traditionally serve as intermediaries between research institutions, academia, government agencies and farmers, facilitating the flow of knowledge and resources to improve agricultural productivity and sustainability.
6. **Monitoring and evaluation**: Continuous monitoring and evaluation are essential to assess the uptake, effectiveness and impact of the technology. Feedback from farmers, extension agents and other stakeholders is collected to identify challenges and refine strategies to enhance the scalability and sustainability of the technology.
7. **Policy support**: Governments and policymakers play a key role in creating an enabling environment for technology transfer in agriculture through supportive policies, investments in research and development, infrastructure development and incentives for innovation adoption. Policy frameworks that promote knowledge sharing, collaboration and public-private partnerships facilitate the dissemination and adoption of agricultural technologies.

**Technology transfer methods:**

1. **Training workshops**: Conducting training workshops is an effective way to transfer technology and knowledge to farmers. Training workshops provide a platform for interactive learning, allowing farmers to acquire new skills and information through lectures, demonstrations and hands-on exercises.
2. **Farm visits and consultations:** Extension agents conduct farm visits and consultations to provide farmer-specific advice and guidance to individual farmers. During these visits, extension agents assess the specific needs and challenges of farmers, offer recommendations based on scientific knowledge and best practices, and provide technical assistance on various aspects of crop production, livestock management and farm operations.
3. **Demonstrations and field days**: Organising field demonstrations and farmer field days allows farmers to observe first-hand the implementation and benefits of new technologies and practices. Extension agents set up demonstration plots where farmers can see the performance of improved varieties, planting techniques, irrigation methods, or pest management strategies. Field days provide opportunities for farmers to ask questions, exchange ideas and learn from each other's experiences.

4. **Mobile advisory services:** With the widespread use of mobile phones, mobile advisory services have emerged as a convenient and accessible method of technology transfer in agriculture. Extension agencies and agricultural organisations send Short Message Service (SMS) and voice messages over social media platforms to disseminate timely information, weather forecasts, market prices, pest alerts, and agronomic advice to farmers. Mobile advisory services reach a large number of farmers quickly and cost-effectively, enabling them to make informed decisions and adopt recommended practices.
5. **Farmer field schools:** Farmer field schools (FFS) are participatory learning platforms where groups of farmers engage in experiential learning and experimentation. FFS sessions typically involve a series of field-based activities, discussions, and group exercises focused on specific agricultural topics or themes. Farmers learn by doing, working collaboratively to test new technologies, evaluate different practices, and solve problems collectively. FFS promote peer-to-peer learning, empowerment and farmer-led innovation.
6. **Printed extension materials**: Distributing extension materials such as pamphlets, brochures, manuals, fact sheets and posters is a traditional method of technology transfer in agriculture. Extension materials contain practical information, illustrations, and guidelines about various agricultural topics, making them valuable educational resources for farmers. Extension materials can be distributed during training workshops, farm visits, or community events and may be available in print or digital formats.
7. **Radio and television programmes:** Broadcasting agricultural radio and television programmes are effective ways to reach remote and rural communities with agricultural information and extension services. Radio and television stations air programmes dedicated to agricultural topics, featuring expert interviews, farm reports, success stories, and educational segments. These programmes provide farmers access to timely information, market updates, weather forecasts and technical advice, enhancing their knowledge and decision-making abilities.

**Participatory approach in technology transfer**

The participatory approach in technology transfer emphasises the active involvement and collaboration of farmers and other stakeholders throughout the process of technology dissemination and adoption. Unlike traditional top-down approaches where knowledge is transferred unilaterally from experts to farmers, the participatory approach recognises farmers as active participants, decision-makers and co-creators of knowledge. This approach aims to empower farmers, enhance their capacities and promote sustainable agricultural development through inclusive and participatory processes.

**Key principles of the participatory approach in technology transfer:**

1. **Inclusiveness:** The participatory approach involves all relevant stakeholders, including farmers, extension agents, researchers, policymakers and local communities. It ensures that the voices and perspectives of all stakeholders are heard and considered in the decision-making processes related to technology transfer and agricultural development.
2. **Empowerment**: Participatory approaches empower farmers by recognising their knowledge, skills, and expertise. Farmers are actively engaged in identifying their needs, setting priorities, and co-designing solutions that are appropriate and relevant to their farming systems. By involving farmers in decision-making processes, the participatory approach enhances ownership, commitment and sustainability of technology adoption efforts.
3. **Collaboration and partnership**: The participatory approach promotes collaboration and partnership among diverse stakeholders, fostering synergies and leveraging collective strengths. It encourages the exchange of knowledge, expertise and resources among farmers, extension agents, researchers, NGOs, government agencies and other actors. Collaborative partnerships enhance the effectiveness, scalability and impact of technology transfer.

4. **Participatory learning and action**: Participatory approaches emphasise experiential learning and action-oriented approaches, such as farmer field schools, learning groups and participatory action research. Farmers engage in hands-on activities, field experiments and problem-solving exercises to explore new technologies, test innovative practices and learn from each other's experiences.
5. **Adaptation and flexibility**: The participatory approach recognises the diversity of farming systems, socio-economic contexts and local realities. It emphasises flexibility and adaptability in technology transfer processes, allowing for the customisation and tailoring of interventions to suit the specific needs, preferences and constraints of farmers. Participatory approaches promote bottom-up innovation and continuous learning, enabling farmers to adapt and refine technologies based on local feedback and experiences.
6. **Capacity building and extension services**: Participatory approaches prioritise capacity building and extension services to support farmers in adopting and implementing new technologies. Extension agents play facilitative roles, providing technical assistance, training and advisory support to farmers. Extension services are demand-driven, responsive to farmers' needs and delivered through participatory methods that promote interactive communication, knowledge sharing and mutual learning.

**Advantages of the participatory approach in extension delivery**

The participatory approach in technology transfer offers several key advantages which contribute to more effective, sustainable and equitable outcomes. Some of the advantages are:

**a.** recognising knowledge, skills and experiences of farmers as valuable assets.

**b.** enabling the co-creation of relevant and customised solutions that address the specific needs, preferences and constraints of farmers.

**c.** enhancing the relevance, acceptability and legitimacy of technologies by incorporating local knowledge, practices and cultural norms into the design and implementation process.

**d.** fostering community ownership and collective action that promotes the long-term sustainability of technology transfer initiatives.

**e.** strengthening the capacity and effectiveness of extension agents by promoting facilitative, participatory and client-centred approaches in extension delivery.

**f.** stimulating continuous learning, innovation and adaptive management among farmers, extension agents and other stakeholders.

**The key stages of the participatory extension approach**

The participatory extension approach typically follows a cyclical process, which includes several key stages. These stages are designed to engage farmers and other stakeholders in collaborative decision-making, problem-solving and knowledge-sharing processes. The key stages of the participatory extension approach cycle are:

1. **Preparation and planning**: In this stage, extension agents and stakeholders engage in preparatory activities to identify objectives, assess needs and plan interventions. This may involve conducting baseline surveys, stakeholder consultations and participatory rural appraisals to gather information about farmers' priorities, challenges and opportunities. Based on the findings, extension agents develop work plans, set goals, and design strategies for technology transfer and extension activities.
2. **Technology identification and selection**: In this stage, extension agents, farmers and other stakeholders jointly identify appropriate technologies, innovations and practices that address specific agricultural challenges and opportunities. Technologies are selected based on their relevance, feasibility and potential impact on improving productivity, sustainability and

livelihoods. Participatory methods such as focus group discussions, field visits, and farmer surveys are used to prioritise the technologies.

3. **Adaptation and testing**: Identified technologies are adapted and tested to ensure their suitability and effectiveness in local contexts. Approaches such as on-farm trials, where demonstration plots are used to evaluate technologies under real-life conditions and gather feedback from farmers. Farmers actively participate in testing and adapting the technologies, providing valuable insights and suggestions for improvement.
4. **Training and capacity building**: Training workshops, farmer field schools, and hands-on demonstrations are organised to impart technical know-how, agronomic practices and problem-solving skills. Extension agents serve as facilitators and advisors, supporting farmers in learning, experimenting and applying new knowledge in their farming operations.
5. **Technology adoption and implementation**: Once farmers are trained and equipped with the necessary knowledge and skills, they begin to adopt and implement the selected technologies on their farms.
6. **Monitoring and evaluation**: Throughout the extension cycle, monitoring and evaluation activities are conducted to assess the progress, effectiveness and impact of the interventions. Key performance indicators are used to measure changes in farmers' knowledge, attitudes, practices and livelihoods.
7. **Reflection and learning:** Extension agents and stakeholders regularly review and reflect on their experiences, challenges and lessons learned from the implementation of technology transfer interventions.
8. **Technology modification:** Based on the findings from monitoring, evaluation and reflection activities, extension agents and stakeholders make adjustments and adaptations to extension interventions as needed.

By following these key stages of the participatory extension approach cycle, extension agents and stakeholders can facilitate the transfer of technology and knowledge in agriculture in a collaborative, inclusive, and empowering manner, leading to improved agricultural productivity, sustainability, and livelihoods.

**Learning Tasks**

1. Define technology transfer in agriculture
2. Explain the technology transfer methods used in agriculture
3. Discuss how to use the various components of technology transfer to improve agricultural production.
4. Compare and contrast conventional and participatory technology transfer methods in crop production.

## Pedagogical Exemplars

**Think pair share:** With input and support from the teacher, learners working in pairs bring out the meaning of agricultural extension and its importance in agricultural production. Teachers should encourage learners to share their findings with their partners and then with the class.

**Structured talk for learning:** The teacher groups learners and provides background information about technology transfer and the various methods used, to enable them to discuss the concept. Teachers should use probing questions to ensure that all learners are actively involved in the lesson,

**Digital learning:** Learners in their groups browse the Internet to search for information on participatory extension service delivery and present oral or written reports in a plenary session.

Learners who are more proficient at using the Internet should assist other learners who may have difficulty accessing the information

## Key Assessments

**Assessment Level 1**: What is technology transfer in agriculture?

**Assessment Level 2:** Explain and give three factors about the importance of agricultural extension in agricultural production.

**Assessment Level 3**: Discuss the contributions of technology transfer by extension services to agriculture.

**Assessment Level** 4: Evaluate the effects of participatory extension services delivery on vegetable crop and ornamental plant enterprises.

## Section 8 Review

The section was devoted to helping learners identify the economic importance of vegetable crops and ornamental plants. This included factors such as income generation, provision of food, and employment to the producer and the provision of raw materials, export earnings and participation in international trade, as a catalyst for developing and expanding national agricultural inputs. The section also looked at technology transfer which is an integral part of the extension delivery process involving the transfer and spread of technical innovation to the farming population. Technology transfer is geared towards achieving three main outcomes, namely increasing agricultural productivity, reducing production costs and lowering consumer prices. With technology transfer more emphasis is placed on the participatory extension approach which mainly uses the bottom-up approach with farmers and extension agents working together to identify needs and find solutions. It prioritises farmers' problems based on the needs of the farmers and ensures that farmers are involved in decision-making.

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# SECTION 9: THREATS OF CLIMATE CHANGE AND MITIGATION MEASURES

Strand: **Agriculture and Climate**

**Sub-Strand:** Climate Variability, Adaptation and Mitigation Strategies

**Learning Outcomes:**

1. *Explain climate change and its implications on agriculture.*
2. *Explain the adaptation of society and agriculture to climate change.*
3. *Explain climate change mitigation measures concerning society and agriculture.*

**Content Standards:**

1. Demonstrate knowledge and understanding of climate change and its threat to environmental stability and rural livelihood sustainability.
2. Demonstrate knowledge and understanding of climate change adaptation and its relevance to sustainable rural agriculture.
3. Demonstrate knowledge and understanding of climate change mitigation measures and their relevance to sustainable rural agriculture.

## INTRODUCTION AND SECTION SUMMARY

This section deals with climate change – its causes, effects on crop growth and yield, as well as the conventional and indigenous strategies for combating climate change. Learners need to have a good understanding of how agricultural production might need to change because of the effects of climate change. This will help them to make better-informed decisions about what to grow and measures to put in place to ensure large yields and high productivity. All learners are expected to be able to explain how both climate change and its mitigation measures affect agricultural production. To deliver the course effectively, the pedagogical approaches to employ include talk for learning, structured talk for learning, enquiry-based learning and experiential learning. Issues of climate change are also considered in Geography hence learners can supplement their knowledge with information on climate change from the Department of Geography.

This section runs over four weeks, from Week 20 to Week 23, with the following learning indicators.

**Week 20:** Explain the causes of climate change and current world disasters

**Week 21:** Discuss increasing drought, pestilence and decreasing crop yields.

**Week 22:** Explain indigenous and conventional strategies for dealing with climate change and climate variability.

**Week 23:** Discuss the effects of indigenous and conventional mitigation measures for combating climate change on agricultural production.

## SUMMARY OF PEDAGOGICAL EXEMPLARS

The choice of pedagogical strategy is key in the teaching and learning process. The teacher must create activities that facilitate learning and enhance a deeper and more meaningful understanding of the subject. The learning indicators in this section deal with the causes, effects, remedies and their impact on agricultural productivity. It is, therefore, necessary to adopt talk for learning and

experiential learning approaches to facilitate the teaching. Where possible, subject specialists can be invited as guest speakers to explain and discuss climate change issues with learners. Community visits have also been suggested and teachers should lead and guide learners as they move into the community to seek information.

## ASSESSMENT SUMMARY

The concept of climate change, with its potential consequences and mitigations, requires assessment strategies that ensure a blend of recall and application of knowledge acquired during the course. Therefore, a variety of individual and group assessment techniques have been suggested to assess learners' understanding and demonstration of understanding, such as oral and written responses to questions and the use of essays to assess critical reasoning. The teacher should provide constructive feedback to learners based on observations, highlighting areas of improvement, and encouraging further practice wherever appropriate. A conscious effort should be made to integrate differentiation into the assessment process to take care of the varying levels of learners' abilities and capabilities in the class.

# Week 20

**Learning Indicator:***Explain the Causes of Climate Change and Current World Disasters.*

## Theme or Focal Area: Causes of Climate Change and Current World Disasters

There is increasing evidence that the Earth's climate is changing largely due to human activities. Scientific evidence shows that life on our planet is in danger from climate change. The atmosphere and oceans have become warmer, accompanied by a rise in sea level, a strong decline in Arctic sea ice and other climate-related changes. The impacts of climate change on people and nature include unprecedented flooding, heat waves, wildfires and rising temperatures with accompanying damage costing billions of United States dollars. The way forward requires society to apply scientific information to make informed decisions about how to reduce the magnitude of climate change and how to adapt to its impacts.

### Basics of climate change: Greenhouse gases affect the Earth's energy balance and climate

The Sun serves as the primary energy source for Earth's climate. Some of the incoming sunlight is reflected directly back into space, especially by bright surfaces such as ice and clouds, and the rest is absorbed by the atmosphere and the Earth's surface. Much of the solar energy absorbed by the earth is re-emitted as heat in the form of longwave or infrared radiation. The atmosphere in turn absorbs and re-radiates heat, some of which escapes to space. Any disturbance to this balance of incoming and outgoing energy will affect the climate.

If all the heat energy emitted from the earth's surface passed through the atmosphere directly into space, the earth's average surface temperature would be tens of degrees colder than observed. Greenhouse gases in the atmosphere including, carbon dioxide, methane and nitrous oxide plus water vapour, absorb and emit heat energy in all directions (including downwards), keeping the Earth's surface and lower atmosphere warm [Figure 1], supporting both plant and animal life on earth. Adding more greenhouse gases to the atmosphere enhances the effect, making the Earth's surface and lower atmosphere even warmer.

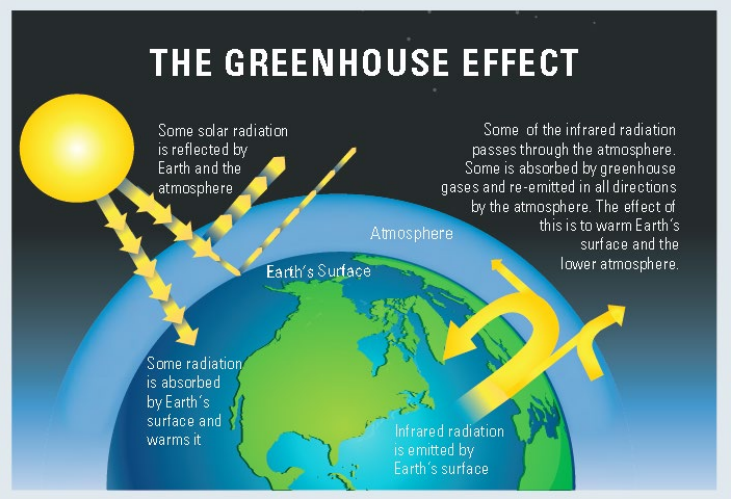


**Figure 1:** *Greenhouse effect in the atmosphere.*

The greenhouse gases such as carbon dioxide ($CO_2$) are emitted from the Earth's surface. Human activities – especially the burning of fossil fuels (coal and petroleum products) plus charcoal and wood, since the start of the Industrial Revolution – have increased atmospheric $CO_2$ concentrations by more than 40%. Other human activities such as clearing forests for farming and animal rearing, also contribute largely to global warming. Since 1900, the global average surface temperature has increased by about 1°C (1.8°F). The atmospheric concentrations of carbon dioxide, methane, and

nitrous oxide have increased significantly. The concentration of $CO_2$ has since increased by over 40%, methane by more than 150% and nitrous oxide by roughly 20%. Increases in all three gases contribute to the Earth's warming with the increase in $CO_2$ playing the largest role. This has been accompanied by the warming of the ocean, a rise in sea level, a strong decline in Arctic sea ice, widespread increases in the frequency and intensity of heat waves and many other associated climate effects. Much of this warming has occurred in the last five decades and is responsible for the observable climate change being experienced today.

Since 1958, there has been a steady annual increase in $CO_2$ concentration in the earth's atmosphere (Figure 2). The up-and-down saw-tooth pattern in Figure 2 reflects seasonal changes in the release and uptake of $CO_2$ by plants.

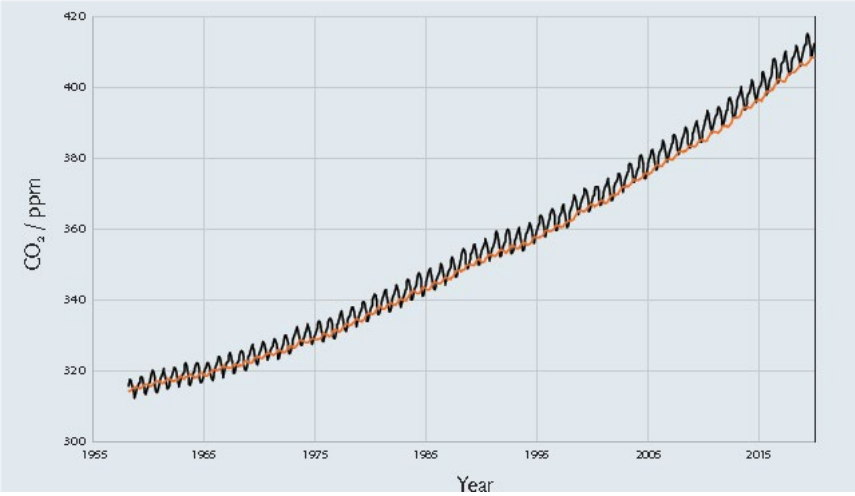


**Figure 2:** *Atmospheric CO2 concentration since 1958 from the Mauna Loa Observatory in Hawaii (black) and from the South Pole (red).*

**Some key causes of current world disasters due to climate change:**

1. **Rising temperatures:** Global warming caused by the increased concentration of greenhouse gases in the atmosphere, primarily carbon dioxide from burning fossil fuels, leads to higher average temperatures. This contributes to heatwaves, droughts and wildfires, which can have devastating impacts on ecosystems, agriculture and human health.
2. **Changing rainfall patterns:** Climate change disrupts traditional precipitation patterns, causing shifts in rainfall distribution and intensity. This can result in both prolonged droughts and heavy rainfall events, leading to water scarcity or flooding and landslides.
3. **Melting of glaciers and polar ice:** The rising temperatures cause the glaciers and icebergs in the Arctic and Antarctic regions to melt, resulting in the rising of the sea level.
4. **Expansion of seawater:** Rising temperatures cause the expansion of seawater, further raising the sea level, and causing tremendous threats and damage to coastal communities. Actual damage inflicted includes coastal erosion, storm surges and flooding. This situation is being experienced along the coastal areas of Ghana, particularly in the Keta area in the Volta region and Nkotompo in the western region.
5. **Extreme weather events:** Climate change intensifies the frequency and severity of extreme weather events such as hurricanes, cyclones and typhoons, causing widespread devastation and loss of life and property.
6. **Ocean acidification:** Increased carbon dioxide levels, do not only contribute to global warming, but also lead to ocean acidification. This impacts marine ecosystems, particularly coral reefs, and threatens the livelihoods of communities that depend on ocean resources.

7. **Biodiversity loss:** Climate change contributes to changes in ecosystems hence habitat loss, leading to shifts in species distribution and increased risks of species extinction.
8. **Economic and social inequities:** Vulnerable populations, particularly in developing countries, are disproportionately affected by climate change disasters due to their limited resources, inadequate infrastructure and lack of adaptive capacity. This can increase existing economic and social disparities.
9. **Feedback loops:** Some climate change impacts trigger feedback loops that accelerate the process. For example, melting Arctic ice reduces the Earth's albedo (reflectivity), causing more sunlight to be absorbed by the darker ocean waters, leading to further warming and ice melting.

Addressing the causes of current world disasters due to climate change requires global efforts (i) to reduce greenhouse gas emissions, (ii) to promote the transition to renewable energy sources, and (iii) to encourage enhanced adaptation and resilience measures, including promoting sustainable land and water management practices. International cooperation and policy interventions are crucial to mitigating the impacts of climate change and minimising the occurrence and severity of climate-related disasters.

**Learning tasks**

1. Discuss the causes of climate change and their relationship with current world disasters.
2. Create a cause and effect diagram (also known as a fishbone diagram) that represents the causes and consequences of climate change-induced disasters.
3. Organise a class debate on human versus natural factors in causing climate change and disasters.

## Pedagogical Exemplars

**Structured talk for learning:** The teacher introduces the lesson on climate change and its global impacts and provides context by mentioning recent climate-related disasters. The teacher should also explain that these disasters are not isolated events but are linked to larger climate change patterns. The teacher should provide leading questions to help learners take part in the discussion

**Enquiry-based learning:** In groups, learners browse the Internet for information on climate change and its relationship with current world disasters. 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 in discussing their findings.

## Key Assessments

**Assessment Level 1**: What are greenhouse gases?

**Assessment Level 2:** Describe the relationship between human activities and greenhouse gas emissions.

**Assessment Level 3**: How do natural factors, such as volcanic eruptions, contribute to climate change?

**Assessment Level 4:** Discuss how greenhouse gases trap heat and cause global warming.

# Week 21

**Learning Indicator:** *Discuss the Consequences of Climate Change on Crop Yields.*

## Theme or Focal Area: Increasing Drought, Pestilence and Decreasing Crop Yields

Increasing drought, pestilence, and decreasing crop yields are interconnected challenges in agriculture that have significant implications for food security and livelihoods.

**Major consequences of climate change**

1. **Increasing drought due to unreliable precipitation patterns and higher temperatures:**
   a. Unreliable precipitation patterns cause more frequent and prolonged droughts in certain regions.
   b. Higher temperatures contribute to increased evaporation, drying up of water sources and soil moisture.
   c. These have serious consequences for agriculture, as crops and ornamental plants rely on adequate water availability to grow and thrive. Droughts lead to reduced crop yields, livestock losses and sometimes total crop failure, affecting food production and livelihoods.
2. **Increasing incidence and severity of pests and diseases:** Warmer temperatures and changing weather patterns create favourable conditions for the proliferation of pests and diseases that affect crops and livestock. Pests, such as insects and pathogens (e.g. bacteria, viruses and fungi), thrive in warmer environments and expand their geographical range. Large infestations damage crops and livestock, reduce yields, and can lead to increased pesticide use. In addition to crop and livestock losses, the reliance on pesticides can have negative environmental and health impacts.
3. **Declining crop yields:** The combination of droughts and increased pest pressure can collectively lead to a decline in crop yields. Changes in temperature and rainfall can disrupt plant growth cycles, affecting flowering, pollination and fruiting. Extreme weather events such as heatwaves can damage crops and stress plants. All these factors interact to reduce agricultural productivity and can lead to food scarcity and higher prices.
4. **Food insecurity:** The consequences of increasing drought, pestilence and decreasing crop yields harm food security. With less water available for irrigation, reduced crop yields and losses due to pests, communities that rely heavily on agriculture face challenges in ensuring an adequate and nutritious food supply. Vulnerable populations, particularly in developing countries, are disproportionately affected by these climate-induced changes, leading to potential malnutrition and food insecurity.

Addressing these challenges requires adopting climate-resilient agricultural practices. Farmers can implement water-efficient irrigation systems, grow drought-tolerant crop varieties, and employ integrated pest management techniques. Early warning systems for pest outbreaks and weather events can help farmers take preventive measures. Improving soil health and implementing agroforestry practices can also enhance ecosystem resilience.

**Learning Tasks**

1. Learners browse the Internet and read about the topic before the lesson.
2. Learners, in class, go to the website of the Ghana Meteorological Services to download temperature and rainfall data for any region or city over the last 30 years and plot graphs for discussion.

3. Learners grow suitable vegetables in plastic bottles and subject them to different temperatures or watering regimes for about three weeks, and study the development patterns by recording changes in appearance including height and number and size of leaves.
4. Learners should browse the Internet to list the effects of increasing drought and pestilence, due to climate change on crop yield.
5. Discuss the future of food security in Ghana in a changing climate.

## Pedagogical Exemplars

**Structured talk for learning:** The teacher should introduce the lesson on the impacts of climate change on agriculture. The teacher should ask leading questions to get feedback from learners.

**Problem-based learning:** The teacher puts learners in groups and challenges them to search the Internet to find out the consequences of climate change on crop yield. 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 most appropriate websites. Where necessary, the teacher should support learners by providing appropriate website links.

**Experiential learning:** Learners in groups grow selected vegetables in plastic containers under different temperature or watering regimes (whichever is appropriate) study the development of the plants and report to the class. The growth records should be interpreted in terms of rising temperatures or increasing water stress.

## Key Assessments

**Assessment Level 1:** Outline the consequences of climate change on crop yield

**Assessment Level 2:** Explain the consequences of climate change on crop yield

**Assessment Level 3:** Discuss the relationship between rising temperatures and reduced water availability for agricultural activities.

**Assessment Level 4:** Analyse the combined effects of increasing drought, pestilence, and decreasing crop yields on local communities and their food systems.

# Week 22

**Learning Indicator:** *Explain Indigenous and Conventional Strategies for Dealing with Climate Change and Variability.*

## Theme or Focal Area: Indigenous Strategies for Dealing with Climate Change and Variability

Climate variability is the annual or seasonal variation observed in the physical factors of weather such as temperature and precipitation. The long-term persistence of these variabilities leads to climate change.

Indigenous communities have developed diverse strategies over generations to cope with climate change and variability. These strategies are often based on traditional knowledge, dependent on critical observation and deep understanding of local ecosystems, and the interconnectedness between nature and human well-being. Some examples of indigenous strategies for dealing with climate change and variability include:

1. **Traditional Ecological Knowledge (TEK):** Indigenous communities possess a wealth of knowledge about their environment, including natural indicators for predicting seasonal weather patterns, many of which are based on the flowering of certain plants and the movement and presence of some animals, particularly birds. This knowledge is passed down through generations and helps predict and allows them to adapt to changing climatic conditions.
2. **Traditional farming and agriculture:** Indigenous farmers often employ traditional agricultural practices that are well-adapted to local climates and ecological conditions. This includes planting diverse crops on the same farm, using crop rotation and selecting resilient crop varieties that are suited to specific ecologies. Such farming practices ensure reduced damage by pests and diseases.
3. **Crop diversity/biodiversity conservation:** Indigenous farmers often practice agro-biodiversity by cultivating a variety of crops with different growth requirements and resilience to various climatic conditions. This diversity ensures food security, even when some crops are affected by extreme weather conditions others survive and produce economic yields.
4. **Territorial management:** Many indigenous groups have developed intricate land management practices that promote sustainable resource use. These practices involve rotational farming, controlled burning and protection of critical ecosystems to maintain biodiversity and resilience in the face of climate change.
5. **Water management techniques:** Indigenous communities have developed efficient water management techniques, such as building terraces, canals and reservoirs to capture and store water during rainy seasons for use during droughts and managing irrigation systems sustainably. These methods help ensure a steady water supply for agriculture and other needs. In some communities, forests are preserved around rivers and other water bodies to prevent drying up during the dry season. Farming close to these water bodies is prohibited thus preventing the cutting down of trees around the water bodies and also reducing silting.
6. **Cultural fire management:** Some indigenous communities use controlled burning practices to prevent larger wildfires and promote the growth of certain plants. The controlled burning reduces fuel loads, enhances soil fertility and maintains the health of ecosystems.
7. **Nomadism**: Nomadic and semi-nomadic indigenous groups adjust their locations in response to changing climatic and environmental conditions by moving with their herds or crops. This mobility allows them to access different resources and adapt to shifts in vegetation and water availability.

8. **Resilient livelihoods:** Indigenous economies often incorporate a mix of activities, such as fishing, hunting and other crafts with their farming. This diversity of livelihoods provides a buffer against the impacts of climate-related disruptions on any single activity.
9. **Cultural and spiritual practices:** Indigenous cultures often have rituals and ceremonies that are closely tied to natural phenomena. These practices reinforce the connection between humans and nature and can foster a sense of responsibility for environmental protection.
10. **Sustainable resource use:** Indigenous communities often adhere to principles of sustainable resource use, ensuring that the environment is not overexploited and that resources are managed in a way that allows for regeneration and continuity. Their land stewardship practices involve responsible management of land and natural resources to maintain ecological balance and ensure the well-being of current and future generations.
11. **Information sharing through storytelling:** Indigenous communities use oral traditions and storytelling to transmit knowledge about climate variability and adaptation strategies. This allows their wisdom to be shared across generations.

Acknowledging and respecting indigenous knowledge and practices are essential for developing effective and inclusive climate change adaptation strategies. Collaborating with indigenous communities, incorporating their perspectives and supporting their autonomy and rights are crucial steps in addressing climate change in a way that is both culturally sensitive and environmentally sustainable.

**Learning Tasks**

1. Organise a panel discussion with guest speakers from indigenous communities, researchers, and activists who have expertise in indigenous knowledge and climate adaptation.
2. Design a community engagement project in which learners visit local communities to understand the indigenous strategies, hence promoting awareness and respect for indigenous knowledge and practices that help combat the negative effects of climate change.
3. Share stories or case studies from indigenous communities that highlight specific strategies they employ to combat the negative effects of climate change.
4. Learners research and propose ways to support and preserve indigenous knowledge and practices.

## Pedagogical Exemplars

**Talk for learning:** The teacher and learners share fables and stories about the strategies that indigenous people employ to combat the negative effects of climate change.

**Project-based learning:** The teacher puts learners in groups and takes them to the local community to listen to and compile indigenous strategies for combating climate change and variability. Learners write information in their field notebooks and present group reports. The teacher should provide necessary support for all learners, including learners having difficulties and those requiring additional challenges.

**Structured talk for learning:** The teacher organises a panel discussion with guest speakers to talk about the role of indigenous knowledge in adapting to climate variability and climate change. The teacher should ensure that all learners take an active part in the ensuing discussion. Students in groups discuss the salient points raised and submit reports.

## Key Assessments

**Assessment Level 1:** State the difference between climate variability and climate change.

**Assessment Level 2:** Explain the indigenous strategies for combating climate change.

**Assessment Level 4**: Evaluate the significance of indigenous knowledge in adapting to climate change and variability.

## Theme or Focal Area: Conventional Responses to Climate Change

Conventional responses to climate change refer to strategies and actions that are commonly pursued by governments, organisations and individuals to address the challenges posed by global warming and adapt to the impacts of climate change. These responses often involve technological, policy and behavioural approaches. Some key conventional responses to climate change include:

1. **Renewable energy transition:** One of the primary conventional responses is transitioning from fossil fuels to renewable energy sources such as solar, wind, hydroelectric and geothermal power. This approach also involves adopting cleaner energy sources, improving energy efficiency, implementing emission reduction policies and promoting renewable energy technologies. This shift aims to reduce greenhouse gas emissions and promote sustainable energy alternatives.
2. **Energy efficiency improvements:** Improving energy efficiency in various sectors such as transportation, buildings and industries. This includes measures such as using energy-efficient appliances and implementing more efficient transportation systems.
3. **Afforestation and reforestation:** Planting trees (afforestation) and restoring degraded forests (reforestation) are important strategies for carbon trapping and usage. In Ghana, tree seedlings are planted every year in the Green Ghana Initiative to combat some aspects of climate change. Trees absorb carbon dioxide from the atmosphere thus helping to mitigate its effects on climate change.
4. **Policy frameworks and agreements:** Governments and international bodies work together to establish policies, regulations and agreements to address climate change. The United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, for example, aim to limit global warming to well below $2^0$C above pre-industrial levels.
5. **Carbon pricing and market mechanisms:** Conventional responses include implementing carbon pricing mechanisms such as taxing carbon or emissions beyond a specified concentration. These measures force industries to reduce emissions and invest in cleaner technologies.
6. **Climate-resilient infrastructure:** Building infrastructure that can withstand the impacts of climate change, such as rising sea levels and extreme weather events, is a crucial response. This includes constructing flood barriers and sea defence walls, improving drainage systems, and designing more resilient buildings.
7. **Public awareness and education:** Raising awareness about climate change and its impacts involves educational campaigns and initiatives that inform the public, policymakers and businesses about the importance of taking action.
8. **Adaptation and disaster preparedness:** This includes developing disaster preparedness plans and enhancing early warning systems.
9. **Sustainable agriculture and land use:** Implementing sustainable agricultural practices, such as no-till farming and agroforestry, can help reduce emissions from agricultural machines and increase resilience to climate change.
10. **Climate finance:** Climate finance involves funding projects focused on climate mitigation, adaptation, and technology transfer in developing countries.

11. **Research and innovation:** While conventional responses play a significant role, there is also growing recognition of the importance of incorporating indigenous knowledge in climate change strategies for a more holistic and effective approach. While conventional responses have made significant strides in addressing climate change, some critics argue that they may not be sufficient to achieve the necessary emission below catastrophic levels. Transitioning to more transformative approaches and exploring nature-based solutions are gaining prominence as complementary strategies to conventional responses.

**Learning Tasks**

1. Learners identify conventional climate-related initiatives or projects in their community.
2. Analyse conventional climate agreements and the challenges faced in implementing the agreements.
3. Learners design projects aimed at reducing greenhouse gas emissions.

## Pedagogical Exemplars

**Structured talk for learning:** The teacher provides an overview of conventional ways of tackling climate change and leads a discussion about the effectiveness of conventional responses. Learners take notes and list conventional climate-related initiatives.

**Digital learning:** Learners in groups browse the Internet and other sources to identify conventional strategies for mitigating climate change and present reports either orally or in written form.

**Project-based learning:** Learners, in groups, design projects that can reduce greenhouse gas emissions and attach their written reports on the walls for peer assessment in a 'gallery walk'. More confident learners should take a lead role in supporting other learners.

## Key Assessments

**Assessment Level 1**: Give three examples of renewable energy usage in Ghana.

**Assessment Level 2**: Explain how renewable energy sources such as solar and wind power can help reduce the impacts of climate change.

**Assessment Level 3**: Discuss the benefits and challenges of implementing carbon taxes.

**Assessment Level 4**: Evaluate the effectiveness of carbon pricing as a strategy to reduce greenhouse gas emissions.

# Week 23

**Learning Indicator:** *Discuss the Effects of Indigenous and Conventional Mitigation Measures for Combating Climate Change on Agricultural Production.*

## Theme or Focal Area: Effects of Indigenous and Conventional Mitigation Measures for Combating Climate Change on Agricultural Production

Both indigenous and conventional mitigation measures for combating climate change can have significant effects on agricultural production. However, their impacts differ in terms of approach, scale and outcomes.

**Summary of indigenous mitigation measures and their effects on agricultural production**:

1. **Traditional farming practices**: Indigenous farming practices such as mulching, cover cropping, bush fallowing and growing drought-tolerant crops often prioritise sustainability, diversity, and resilience. This leads to better soil health, reduced erosion and enhanced water retention, positively impacting agricultural productivity.
2. **Agroforestry and biodiversity**: Indigenous communities often practice agroforestry, integrating trees with crops, which enhances ecosystem stability, improves soil fertility, and provides additional income from non-timber forest products.
3. **Local seed varieties**: Indigenous farmers often maintain a rich diversity of traditional crop varieties adapted to local conditions. Seeds from locally adapted crop varieties are more resilient to climate fluctuations and contribute to larger crop yields.
4. **Water management techniques**: Indigenous communities have developed innovative water management systems such as rainwater harvesting, cover cropping, crop selection and rotation, composting and mulching that optimise water use making agriculture more resilient to changing rainfall patterns, with a resultant yield assurance.
5. **Community-based adaptation**: Indigenous approaches emphasise collective decision-making and adaptive capacity, which fosters community cohesion and enhances resilience to climate-related challenges. These adaptation strategies are planned and executed together by the community members. Some of the community-based adaptation strategies are:
   a. replanting forests and restoring damaged ecosystems.
   b. diversifying crops so that they are better able to adapt to changing climates.
   c. investigating and developing innovative solutions to prevent and manage natural catastrophes.

All these indigenous mitigation measures enhance agricultural production by:

1. promoting sustainable practices.
2. conserving biodiversity.
3. increasing resilience to climate variability.
4. diversifying farming systems.
5. reducing vulnerability to climate extremes,
6. stabilising and increasing yields.

**Summary of conventional mitigation measures and their effects on agricultural production:**

1. **Renewable energy transition:** Conventional mitigation often focuses on transitioning from fossil fuels to renewable energy sources e.g. solar energy, wind energy, hydropower and

geothermal power. While this can reduce greenhouse gas emissions, it may have indirect negative effects on agriculture through changes in energy prices and land use for bioenergy crops.

2. **Intensive agriculture practices:** Some conventional mitigation strategies prioritise intensive agricultural practices including livestock rearing to increase food production. However, these approaches can lead to negative environmental impacts, such as soil degradation and loss of biodiversity.
3. **Afforestation and reforestation:** Planting trees to capture/trap carbon impacts agricultural land availability and positively affects the livelihoods of communities that depend on those lands.
4. **Carbon pricing:** The implementation of carbon pricing mechanisms may increase production costs which would be added to commodities such as equipment, tools, machinery and fertilisers. This development will negatively impact agricultural production.
5. **Technological interventions:** Conventional mitigation often involves technological interventions, such as genetically modified organisms (GMOs) or precision agriculture. The effects of these technologies on agricultural production are the subject of ongoing debates.

Conventional mitigation measures, therefore, have mixed effects on agricultural production. As some strategies prioritise large yields, long-term sustainability and ecosystem health, some high-input practices increase vulnerability to climate shocks and disruptions in resource availability.

**Learning Tasks**

1. Browse the Internet and list the indigenous and conventional mitigation measures for combating climate change.
2. Discuss the indigenous and conventional mitigation measures for combating climate change.
3. Evaluate the impact of the indigenous and conventional mitigation measures for combating climate change on agricultural production.

## Pedagogical Exemplars

**Collaborative learning**: The teacher should put learners in groups to browse the Internet and come up with the impacts of indigenous and conventional mitigation measures for combating climate change on agricultural production. Learners should share their ideas with the whole class.

**Initiating talk for learning:** The teacher should initiate talk for learning and use leading questions to guide learners in their groups to evaluate the impacts of the indigenous and conventional mitigation measures for combating climate change on agricultural production. All learners should be encouraged to participate in the discussion. The teacher should use positive feedback to motivate learners to contribute to the discussion.

## Key Assessments

**Assessments Level 1**: State the impacts of indigenous and conventional mitigation measures for combating climate change on agricultural production.

**Assessments Level 2**: Explain the indigenous and conventional mitigation measures for combating climate change on agricultural production.

**Assessments Level 3**: How can traditional farming practices contribute to making crops more resilient in the face of changing weather patterns?

## Section 9 Review

This section dealt with climate change and its impact on agricultural production. Learners were introduced to the meaning of climate change. The section helped learners identify the indigenous and conventional strategies for dealing with climate change and variability and the impact of the effects of mitigation measures for combating climate change on agricultural production. Learners explored the Internet to search for information for discussion. This helped improve their digital and communicative skills. Resource persons from the local communities were also engaged to help learners understand the indigenous mitigation measures for combating climate change and the effects of these measures on agricultural productivity. The 'gallery walk' made by learners during the presentation of their work enhanced their understanding of the subject matter.

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