



TVET LEVEL II



AGRICULTURE

Food Crop Production

TRAINER MANUAL



Approved by:  Workforce
Development
Authority



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Acknowledgements

Rwanda Polytechnic (RP) would like to officially recognize all parties who contributed actively to the preparation of the Trainer and Trainee manuals of this module. We wish to extend our thanks to various organizations such as Workforce Development Authority (WDA), EDC through its USAID Huguka Dukore Akazi Kanoze (USAID - HDAK), TVET schools, Private Industries, GIZ Hanga Ahazaza Project and other individuals who greatly contributed from the initial concept towards publication of this training manual.



Under Rwanda Polytechnic (RP) supervision and involvement



Under Workforce Development Authority (WDA) guiding policies and directives



With funding provided by USAID through Huguka Dukore Akazi Kanoze (HDAK) project



And with technical support by Education Development Center (EDC) through local and international USAID HDAK experts

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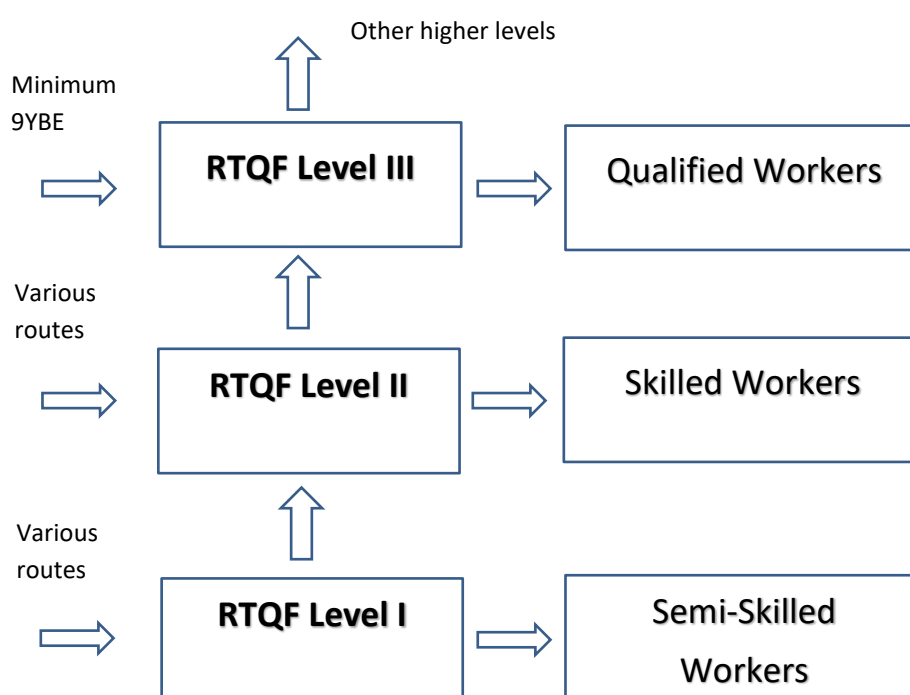
Technical Support

USAID Huguka Dukore Akazi Kanoze (HDAK) project
implemented by Education Development Center (EDC)

Introduction to RTQF Level II Training Modules

Background

Rwanda Polytechnic, with support of and in collaboration with USAID Huguka Dukore Akazi Kanoze, has developed RTQF TVET Level II programs that combine basic education, soft skills and vocational skills modules. Bridging the gap between Level I and Level III programmes, Level II aims to prepare learners who have a minimum education level of Primary 6 or equivalent to continue with their education or become skilled workers in the labour force.



Following the Workforce Development Authority (WDA) curriculum development process that involved experts from Rwanda Polytechnic, Rwanda Education Board, Ministry of Agriculture, technical vocational institutions, Education Development Center, Akazi Kanoze Access and other technical experts, training modules were developed in basic education, soft skills (work readiness) and, initially, agriculture. Additional vocational areas will be added over time. Trainees will be trained in all Basic Education and Soft Skills modules listed below, as well as in 6 - 8 modules that make up their chosen technical vocational programme.

Module Requirements:

Basic Education	Soft Skills	Vocational Skills
- English - Kinyarwanda - Mathematics	- Basic Entrepreneurship Skills - ICT Essentials	Vocational programmes will have a set of 6 – 8 required technical modules.

- Integrated Science (Physics, Chemistry, Biology)

- Communication Skills
- Safety, Health and Sustainable Environment
- Personal Development and Career Guidance

E.g. Food Crop Production and Processing includes the following modules:

1. Food Crop Production
2. Small Scale Post-Harvest Operations
3. Growing Medium
4. Food Safety and Sanitation
5. Food Preservation and Storage
6. Flour Processing

Organization of the Training Manuals

For each module there is a Trainer Manual and a Trainee Manual. These manuals, based on the curricula for each subject, are divided into Learning Units, and each Learning Unit includes 3 – 5 Learning Outcomes. The learning outcomes make up the essential skills, knowledge and attitudes to be acquired by trainees. To make the Trainee Manual more user friendly, Unit and Topic are used respectively for Learning Unit and Learning Outcome. The number of hours per training module varies, ranging between 30 and 120 hours.

Teaching & Learning Methodology of RTQF Level II 2 TVET Materials

The teaching and learning methodology used in the materials is based in experiential and adult learning. Activities are designed to engage trainees, build upon what they know and learn and provide them with opportunities to build their skills in the classroom and in the workplace. More specifically, guiding principles in the development of the manuals include:

- ▶ Building on participants' knowledge, skills and experiences
- ▶ Facilitating a learning process through active engagement of participants rather than through lecturing
- ▶ Providing opportunities to practice – inquiry based and hands on practice, both in the classroom and workplace
- ▶ Using simple and clear language
- ▶ Connecting to the real world: use local resources and the environment for learning
- ▶ Promoting critical thinking through properly debriefing activities and asking questions that get learners to think, analyze, relate issues and topics to their own lives and come up with solutions

- ▶ Applying social inclusion principles: Finding ways to include all types of youth (and trainers) – males and females; different cultural/ethnic/religious backgrounds, people with disabilities (PWD); people with different types of health status ...
- ▶ Encouraging risk taking – promote questioning and being free to explore
- ▶ Promoting habits of mind that support life-long learning: curiosity and wonder, open mindedness, creativity

These principles are reflected in the layout and flow of activities in the manuals:

1. **Key Competencies:** Table found at the beginning of each Learning Outcome that describes the main knowledge, skills and attitudes to be gained by the end of the activities.
2. **Self-Assessment:** Conducted at the beginning and end of each Learning Unit to get a sense of trainees' knowledge and skills going into it and what they have gained by the end of the Learning Unit (and steps they need to take to further their understanding and skills).
3.  **Getting Started Activity:** Typically, a quick activity or questions to 1) give the trainer a sense of trainees' existing knowledge and skills; 2) spark the interest of trainees in the topic; 3) introduce the objectives and key competencies of the topic.
4.  **Problem Solving Activity:** A challenging activity to get trainees engaged and to learn through discovery instead of memorization of facts. A variety of teaching and learning methodologies are used, including individual and group work such as reading real life work-based scenarios and answering accompanying questions to activities such as identifying proper tools and equipment from the school workshop to conduct a certain activity. Following the sharing of responses, the trainer guides trainees through the content and processes being introduced.
5.  **Guided Practice Activity:** Building on the concepts and skills gained in the Problem Solving Activity, the trainer guides trainees through practical examples.
6.  **Application Activity:** Consolidates trainees' knowledge and skills through a real-life application of the topic in the classroom, community or workplace. Trainees are given more independence in applying what they have learned.

7. **Key Facts boxes:** Throughout the Trainee Manual, one will find Key Facts boxes. These contain the main information or content for a given Learning Outcome. They are there for the trainees' reference and are used throughout the different types of activities.



8. **Points to Remember:** List of the top key learning points or “take-aways” from the topic.



9. **Formative Assessment:** Questions and activities to assess trainees' level of understanding of the concepts introduced.



10. **Summative Assessment:** Based on the integrated, real life situation approach used in other TVET levels, this is done at the end of every module for agricultural modules and, with some variations, at the end of each Learning Unit for Basic Education and Soft Skills modules.



11. **Self-Reflection:** Trainees re-take the Self-Assessment given at the beginning of the Learning Unit and identify their strengths, challenges and actions to improve their level of competence.

The Trainer and Trainee Manuals are meant to be used in conjunction with each other and are well coordinated through the headings and labelling of activities. The trainer will always be able to refer trainees to specific activities by the coordinated numbering system. For instance, a specific exercise might be labelled Topic 1.2 Task 2. The Topic is the number of the Learning Outcome and the task is the specific exercise to be done. The Key Facts are also numbered for easy reference. These nor the Self-Assessment tables are in the Trainer's Manual so the trainer should have a copy of both manuals.

The Trainer's Manual includes answers (or guidelines to the trainer as appropriate) to Formative and Summative Assessments as well as to problems given throughout the activities. Summative Assessments are not included in the Trainee's Manual. These are meant to be used as a guide for those who will be developing a context-appropriate Summative Assessment at the end of the Module or Learning Unit. Basic Education and Soft Skills modules include Summative Assessments at the end of every Learning Unit while the technical modules include it only at the end of the module.

Lastly, there is a section in the Trainer's Manual for additional information to the trainer that includes either specific information or references to information that can help them deepen their understanding of the particular content.

FOOD CROP PRODUCTION

Learning Units	Learning Hours	Learning Outcomes
Learning Unit 1: Perform food crop planting activities	30	1.1 Prepare planting operations
		1.2 Carry out sowing/planting operations
Learning Unit 2: Assist in food crops maintenance	24	2.1 Perform crop maintenance practices
		2.2 Assist with managing pests and diseases
		2.3 Use fertilisers on food crops
Learning Unit 3: Assist in harvesting activities of food crops	20	3.1 Determine maturity index for food crops
		3.2 Perform harvesting operations
		3.3 Pack and transport food crop produce

Learning Unit 1: Perform food crop planting activities



Learning Outcomes

By the end of the Learning Unit, trainees will be able to:

- 1.1** Prepare planting operations
- 1.2** Carry out sowing/planting operations

Learning Unit 1 Self-Assessment

- 1.** Ask trainees to look at the illustration above (in their Trainee Manuals) and discuss what they see. What topics do they think this unit will include based on the picture? After some brainstorming, share the main topics.
- 2.** Ask trainees to fill out the self-assessment at the beginning of the unit in their Trainee Manuals. Explain that the purpose of the self-assessment is to become familiar with the topics in the unit and for them to see what they know or do not know at the beginning. At the end of the unit, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas that need improvement and actions to take. The self-assessment is not a test!

Learning Outcome 1.1: Prepare planting operations

	Objectives: By the end of the learning outcome, trainees will be able to: - Identify tools, materials, and equipment needed for planting operations considering the crop - Apply planting material pre-treatments based on seed conditions - Select methods of planting depending on the crop
	Time Required: 15 hours
	Learning Methodology: Individual and group work, discussion, field visit, interviewing
	Materials Needed: Standard training materials – flip chart, markers, tape, A4 paper Planting tools and equipment photos – photos of a spade, shovel, fork, rake, trowel, hoe, wheelbarrow, and pegs and cables Audio equipment—internet, projector, computer, screen
	Preparation: ☐ Research and download photos of the planting tools and equipment listed above. ☐ Arrange the projector, screen, and computer before class. ☐ Contact a local crop farm and confirm that it is possible to tour the farm and interview the farmer.
	Cross Cutting Issues: ✓ Environment and sustainability: Emphasise the relationship between planting seeds and choosing crops to grow with the environment, particularly weather conditions. ✓ Standardisation culture: Recognise that the crop type should be used to determine the planting method and planting methods should be implemented uniformly.
	Prerequisites: ▶ None

Key Competencies:

Knowledge	Skills	Attitudes
1. Identify the criteria for quality planting materials	1. Sort and select planting materials for planting food crops	1. Detail-oriented
2. Describe pre-treatments for food crop planting materials	2. Apply pre-treatments to planting materials	2. Diligent
3. Describe the various methods for planting food crops	3. Select the method of planting suitable to the food crop	3. Methodical



Steps:



Getting Started: What do we know and where are we going?

1. Tell trainees to turn to **Topic 1.1 Task 1** in their manuals and think about the farms that grow crops in or near their community. Instruct them to discuss the following questions and write down their answers with a partner:
 - a. What materials, tools, and/or equipment do the farmers use?
 - b. Draw what they look like below:
 - c. How are they used? What is their purpose?

Answers to the questions above may vary. Encourage students to think creatively. Do not correct their answers yet, as their answers will be verified later on in the Key Facts and Activities.

2. Display photos of planting materials, tools, and equipment. Identify each item for the trainees. For each item they are familiar with, they should identify its use. For each item they are not familiar with, they should note its name.
3. Explain that this topic is going to focus on the materials and tools needed for planting, the pre-treatment of seeds and methods of planting. Review the Key Competencies table together.



Problem Solving Activity

1. Direct trainees to **Topic 1.1 Task 2** in their manuals. Tell them to individually consider the following scenarios and predict which planting method would be best.

Answers are bolded.

- a. You want to plant a lot of carrot seeds. The seeds don't need to be covered with soil and you don't mind if the carrots grow close together.

What should you do?

- i. Drop the seeds in a hole as you walk along a row and cover them as you go.
- ii. **Randomly scatter the seeds on the soil.**
- iii. Carefully place the seeds in holes that are arranged around a mound and separate the mounds by the exact same distance, then cover with soil.

- b. You are planning to plant sorghum. The sorghum plants need to be arranged in a line, but not uniformly. They should be covered with soil.

What should you do?

- i. **Drop the seeds in a hole as you walk along a row and cover them as you go.**
- ii. Randomly scatter the seeds on the soil.
- iii. Carefully place the seeds in holes that are arranged around a mound and separate the mounds by the exact same distance, then cover with soil.

- c. You want to plant maize. The maize seeds should not be overcrowded, but rather planted equidistant apart from each other.

What should you do?

- i. Drop the seeds in a hole as you walk along a row and cover them as you go.
- ii. Randomly scatter the seeds on the soil.
- iii. **Carefully place the seeds in holes that are arranged around a mound and separated the mounds by the exact same distance, then cover with soil.**

2. Ask trainees to compare their answers with a partner, and then the rest of the class. Verify their answers.

3. Tell trainees that seeds are not always ready to be planted as soon as you receive them. With their partner, ask them to consider what they could do to the seeds to prepare them for planting in the following situations:

- a. The seed coats are too dry and cannot absorb water.
- b. The seeds are covered with dirt and other inorganic matter.
- c. The seeds have been exposed to harmful bacteria or microorganisms.

- d. The seeds are dormant and sensitive to light.
4. After a discussion with their partners, ask trainees to share and compare their ideas with the class. Encourage them to think critically and creatively, potentially accessing knowledge from previous modules. Their answers will vary.
5. As a class, read through **1.1 Key Facts**. Tell trainees to do the following:
- a. Circle any tools, material, and equipment you are not familiar with. Ask the trainer for clarification on the items.

Answer: Research more photos, find a sample, or further explain the use of the tools, materials, and equipment in question.

- b. Note the proper terms for the methods described in **Question 1** and the seed pre-treatments described in **Question 3**.

Question 1 Answers:

- Randomly scatter the seeds on the soil = **Broadcast Method**
- Drop the seeds in a hole as you walk along a row and cover them as you go = **Drill Method**
- Carefully place the seeds in holes that are arranged around a mound and separate the mounds by the exact same distance, then cover with soil = **Hill Method**

Question 3 Answers:

- The seed coats are too dry and cannot absorb water. = **Seed Coat Breaking**
- The seeds are covered with dirt and other inorganic matter. = **Cleaning**
- The seeds have been exposed to harmful bacteria or microorganisms. = **Pesticides Treatment**
- The seeds are dormant and sensitive to light. = **Dormancy Breaking**



Guided Practice Activity

1. Ask trainees to open their manuals to **Topic 1.1 Task 3** and read the scenario.

Your friend Damascene has been offered a piece of land and wants to grow beans. It is his first time producing crops and he wants your advice on selecting, pre-treating, and planting the seeds. He wants to plant a large number of seeds and mention that bean seeds germinate quickly.

2. Separate them into small groups to complete the following tasks. Encourage trainees to refer to **1.1 Key Facts** for guidance as needed.
 - a. Describe the factors they should consider when selecting seeds.
Answer: Adaptivity, yield, uniformity, cleanliness, germination, vigour. See descriptions in **1.1 Key Facts**.
 - b. Identify the pre-treatments they should perform if their seeds are covered with dirt and have been exposed to harmful bacteria.
Answer: Cleaning and pesticides pre-treatments.
 - c. Explain the planting method they should use for their seeds.
Answer: Hill method
 - d. List the tools and equipment they will need to perform this planting method.
Answer: Hoe (to create the hills), trowel (to dig the holes), pegs and cables (to design the rows). Other tools possible with explanation.
 - e. Recommend either transplanting or direct seeding and explain why.
Answer: Direct seeding because it is more efficient with a lot of seeds and effective for seeds that germinate quickly.
2. Ask groups to take turns presenting their advice to Damascene to the class. Lead a discussion on any differences in advice and verify the correct answers using the key above.
3. Next, tell trainees to match the planting tools and equipment to their uses by drawing a line. Tell them not to use **1.1 Key Facts** at this time.
4. Once they have completed the matching activity, tell trainees to verify their answers by reading **1.1 Key Facts**. Monitor their self-assessment process and correct any errors.



Application Activity

Organise a visit to a local crop farm with your class. Before the visit, confirm that the farmer or another worker is available to give a tour of the area and answer questions about the planting preparation process.

1. Accompany trainees on a tour of the crop area/field. Instruct them to do the following during the tour, found under **Topic 1.1 Task 4** in their manuals.
 - a. Identify the crop or crops being grown.

- b. Predict the planting methods used based on the type of crops and the arrangement of the crop area/field.
 - c. Identify the various tools and equipment being used by workers at the farm.
2. Facilitate trainees confirming their observations with the farmer or another worker.
3. Invite trainees to interview the farmer using the questions found in the table under **Topic 1.1 Task 4**, plus one of their own. They should write down the farmer's responses. Sample table below.

Questions	Answers
Where do you get your seeds from?	
What pre-treatments do you perform on seeds?	
Do you perform transplanting or direct seeding or both? Which crops do you use each method with?	
Where do you get your tools and equipment from? How do you select them?	
What advice do you have for someone who is preparing planting operations?	
Your Question:	

4. Encourage trainees to assist the farmer with any seed pre-treatments needed. Make sure they wear personal protective equipment (PPE) when handling chemicals.
5. After the visit, facilitate a class discussion on the following points:
 - a. What did you learn?
 - b. What surprised you?
 - c. How is the farmer's experience similar to or different from the information given in **1.1 Key Facts**? Why?



Points to Remember

- During the selection of planting materials, the qualities to be observed include viability, vigour, absence of insects and diseases.
- It is important to wear protective equipment when cleaning and applying pre-treatments to avoid hazards caused by the chemicals or materials.



Formative Assessment

Answers are in bold.

Circle the correct answer for each question:

1. Which is **true** for direct seeding?
 - a. Direct seeding involves lower risk due to more control of weather and other external conditions that affect the seeds and seedlings.
 - b. **Direct seeding involves higher risk due to seedlings' exposure to extreme weather conditions.**
2. What does the drill planting method involve?
 - a. **Seeds are released in a straight line into shallow furrows while walking.**
 - b. Rows are arranged uniformly and equal distances apart.
 - c. No need to cover with soil.
3. Which tool is used to level off freshly turned soil before planting or sowing the crop?
 - a. **Rake**
 - b. Shovel
 - c. Hoe

Write answers to the following:

4. Name two factors that should be considered when identifying and selecting planting tools and equipment:
Possible Answers: Durability, cleanliness, size, cost
5. Name two factors that should be considered when identifying and selecting seeds:
Possible Answers: Adaptivity, yield, uniformity, cleanliness, germination, vigour



Further Information for the Trainer

1. Vegetable Seeding Techniques:
<http://www.interactiveinsightsinc.com/vegetable-seeding-techniques-broadcasting-hills-drills/>
2. Methods of Planting:
<https://www.cropsreview.com/methods-of-planting.html>
3. Seeds vs. Transplants:
<https://organicgrowersschool.org/gardeners/library/seeds-vs-transplants/>

Learning Outcome 1.2: Carry out planting operations

	Objectives: By the end of the learning outcome, trainees will be able to: - Describe and select the types of materials to be used in the planting process - Identify and perform post planting immediate care depending on crop requirements - Recycle, reuse, or dispose of waste to minimize damage to the environment and promote safety
	Time Required: 15 hours
	Learning Methodology: Group work, field visit, demonstration
	Materials Needed: Standard training materials – flip chart, markers, tape, A4 paper
	Preparation: ☐ Organise a visit to a local crop farm. Confirm that the farmer or another worker is available to give a tour and demonstration, as well as answer questions. ☐ Reserve a time to visit the school farm and identify the materials available.
	Cross Cutting Issues: ✓ Environment and sustainability: Emphasise the need to protect the environment especially through disposal of containers of seeds and the recycling of decaying garbage that are left after crop planting. ✓ Standardisation culture: Demonstrate how record keeping ensures standardization and efficiency of farm practices over time.
	Prerequisites: ▶ Learning Outcome 1.1: Prepare planting operations

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe the types of materials used in the planting process	1. Select planting materials according to crops and conditions	1. Detail-oriented
2. Identify the post-planting immediate care processes	2. Apply post-planting immediate care	2. Methodical
3. Describe various waste recycling and disposal procedures	3. Perform procedures for safe disposal and recycling of waste after planting	3. Forward-thinking



Steps:



Getting Started: What do we know and where are we going?

1. Assign trainees to a partner and tell them to discuss the statement: “A plant is only as good as its roots.” Refer trainees to **Topic 1.2 Task 1** in their manuals.
 - a. What do you think this statement means?
 - b. What factors contribute to seed and root growth?
 - c. What materials do you need for planting seeds?
2. Encourage trainees to share and compare their answers with the rest of the class.
3. Explain that this topic will focus on how to tend to seeds that are grown in different media such as in pots, greenhouses and directly into the soil and how to ensure the seeds can thrive. Review the Key Competencies table together.



Problem Solving Activity

1. Tell trainees to consider the following scenario found in **Topic 1.2 Task 2** in their manuals.

Imagine that you are a farmer growing maize. After planting, you observe that some of the maize plants are over-crowded. There are too many of them in one area for proper

growth and access to soil nutrients. At the same time, some of the seeds in other areas were eaten by birds, so the maize seedlings did not grow there.

2. Tell the trainees to discuss the questions with a partner. Encourage them to be creative!

- a. What could you do to address the maize plants that are over-crowded?

Possible Answer: Remove some of the plants that are too close together.

- b. What could you do to address the areas where the seeds have been eaten?

Possible Answer: Transplant or replant seedling to these areas.

- c. How could you combine or coordinate the responses to the two problems?

Possible Answer: Moving plants from over-crowded areas to areas where seeds have been removed/there are no plants.

3. Ask trainees to share their ideas with the rest of the class. After they have discussed, suggest the **Possible Answers** above if they have not been mentioned already.

4. Based on their previous knowledge and experience, tell trainees to discuss the significance of the following for maintaining a farm with a partner:

- a. Waste disposal

- b. Record keeping

5. With their partners, have trainees read through **1.2 Key Facts** and write answers to the following, which correspond to **Questions 1 and 3** above:

- a. What is the process of transplanting plants from an over-crowded area to an open one to optimize plant population in the field?

Answer: Thinning + Gap Filling

- b. What are the three methods for waste management?

Answers:

1. Recycle

2. Reuse

3. Safe disposal

- c. Why is record keeping useful?

Answer: To help plan for the future; to know which planting methods and materials are most effective.

6. After the trainees have read through **1.2 Key Facts** and answered the questions, verify responses with the **Answers** given above.



Guided Practice Activity

Organise a visit to the school farm with your class. Confirm that the farm space is available and there is access to the planting materials and mediums.

1. Tell trainees to collaborate with a small group to do the following tasks, which can be found in **Topic 1.2 Task 3** in their manuals:
 - a. Identify the types of crops being grown on the farm.
 - b. Assess the status of the soil, greenhouse (if applicable), and containers:

Planting Medium or Material	Status
Soil (chemical and physical qualities)	
Greenhouse (if applicable)	
Containers (pots, boxes, etc.)	

- c. Fill out the sample record keeping chart below. Ask the trainer for assistance and information as needed.

Location	Planting Date	Planted Area	Seed Variety	Planting density	Fertiliser Used

- d. Note where the waste is kept and/or disposed of after use. Also, note any observations of recycling or reuse.
2. After the visit, ask the groups to share their experiences and findings.



Application Activity

Organise a visit to a local crop farm with your class. Confirm that the farmer or another worker is available to give a tour and demonstration, as well as answer questions.

1. Tell the class to do the following tasks at the farm from **Topic 1.2 Task 4**:
 - a. Tour the crop field.
 - b. Identify the food crops grown and the media used by taking notes in the chart (sample below):

Food Crops	Media Used

2. If applicable, instruct trainees to observe and assist the farmer as he or she demonstrates how to plant and give post-planting care to the seed.
3. Tell trainees to ask the farmer if he or she uses thinning and gap filling. Identify where this practice has been used and assist, if possible.
4. Encourage trainees to ask the farmer any questions they have about planting operations.
5. After the field visit, facilitate a class discussion using the following questions:
 - a. What did you learn?
 - b. What surprised you?
 - c. How is the farmer's experience similar to and/or different from the information in **1.2 Key Facts**? Why do you think?



Points to Remember

- Wear personal protective equipment (PPE) to avoid potential hazards that can occur during crop planting operations.
- Select crops which are adaptable to local conditions and seasons. If not, there will be no production or severe reduction of production.



Formative Assessment

Answers are in bold.

Complete the following sentences:

1. While plant containers come in various shapes, sizes, and materials, the most common shape is **round/circle**.
2. Mulching prevents **water** loss, protects the seeds from being eaten by birds, and increases the **temperature** around the seed to speed up germination.
3. Soil media must be assessed for their physical and **chemical** properties, such as bulk density and **pH** levels.

Write answers to the following:

4. Name three pieces of data that should be collected during planting record keeping:
Possible Answers: Site location, variety, date of planting, spacing, planted area, fertilisers
5. What is gap filling and why is it used?
Answer: Gap filling is the process of transplanting seedlings from an over-crowded area to an area where the plant seeds were eaten or the plants died/did not germinate. It is used to maximize farm productivity.
6. How should waste be disposed of safely?
Answer: Waste should be placed in a pre-prepared area where it is contained and won't cause harm to the environment.



Further Information for the Trainer

1. Pre-Planting and Post-Planting Tasks in Agriculture:
<https://www.agrifarming.in/pre-planting-tasks-post-planting-tasks-in-agriculture>
2. Plant Crops Under Supervision:
https://www.agriseta.co.za/downloads/LearningMaterial/116200_LG.pdf
3. MINAGRI, (2018). Farmer's diary
4. Good Agricultural Practices for Greenhouse Vegetable Crops:
<http://www.fao.org/3/a-i3284e.pdf>
5. Growing Media, Potting, and Labeling:
<https://courses.cit.cornell.edu/hort494/greenhouse/soil/medialft.html>
6. Definition, Objectives, Advantages of Thinning and Gap Filling:
<https://www.1001artificialplants.com/2019/04/07/define-objectives-advantages-of-thinning-and-gap-filling/>



Self-Reflection

1. Ask learners to re-take the self-assessment at the beginning of the unit. They should then fill in the table in the Trainee's Manual to identify their areas of strength, areas for improvement and actions to take to improve.
2. Discuss trainees' results with them. Identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Learning Unit 2: Assist in food crops maintenance





Learning Outcomes

By the end of the Learning Unit, trainees will be able to:

- 2.1** Perform crop maintenance practices
- 2.2** Assist with managing pests and diseases
- 2.3** Use fertilisers on food crops

Learning Unit 2 Self-Assessment

- 1.** Ask trainees to look at the unit illustration (in their Trainee Manuals) and discuss what they see. What topics do they think this unit will include based on the illustration? After some brainstorming, share the main topics.
- 2.** Ask trainees to fill out the self-assessment at the beginning of the unit in their Trainee Manuals. Explain that the purpose of the self-assessment is to become familiar with the topics in the unit and for them to see what they know or do not know at the beginning. At the end of the unit, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas that need improvement and actions to take. The self-assessment is not a test!

Learning Outcome 2.1: Perform crop maintenance practices

	Objectives: By the end of the learning outcome, trainees will be able to: a. Describe the purposes of various crop maintenance practices b. Explain the different types of crop maintenance practices c. Select and compare crop maintenance practices based on crop needs d. Describe the methods and techniques for performing crop maintenance practices
	Time Required: 8 hours
	Learning Methodology: Brainstorm, independent research, presentation, interviewing, field visit, demonstration
	Materials Needed: • Standard training materials—flipchart, markers, tape, A4 paper
	Preparation: ☐ Organise a visit to a local crop farm. Confirm that the farmer or another worker will be available to give a tour and answer questions regarding crop maintenance practices, specifically fencing and irrigation. ☐ Prepare the flipchart for group presentations.
	Cross Cutting Issues: ✓ Environment and sustainability: Explain the relationship between maintenance practices and the environment/climate, such as the need for irrigation systems. ✓ Gender and inclusion: Consider gender balance when forming small groups.
	Prerequisites: ▶ Learning Unit 1: Perform food crop planting activities

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe the purposes of various crop maintenance practices	1. Select maintenance practices based on crop needs and circumstances	1. Forward-thinking
2. Explain the different types of crop maintenance practices	2. Compare the different methods for each maintenance practice	2. Detail-oriented
3. Describe the methods and techniques for performing crop maintenance practices	3. Practice crop maintenance practices	3. Diligent



Steps:



Getting Started: What do we know and where are we going?

1. Ask trainees to open to **Topic 2.1 Task 1** in their manuals. Instruct them to individually brainstorm what a crop farmer could do in the following situations to promote plant growth:
 - a. The stem/base of a plant is weak.
 - b. Weeds are killing the plants.
 - c. The plant is not secure enough to grow upward.
 - d. There are too many seedlings in one area.
2. Tell trainees to discuss their ideas with a partner.
3. Then, they should discuss with their partners:
 - a. What is the purpose of crop maintenance?
 - b. Why is it important?
4. Ask trainees to share their ideas with the rest of the class. Encourage creativity and critical thinking. There are no right or wrong answers. They should access some prior knowledge, such as the concepts of thinning and gap filling.

5. Explain that this topic is going to focus on different methods of maintaining crops, then review the Key Competencies table together.



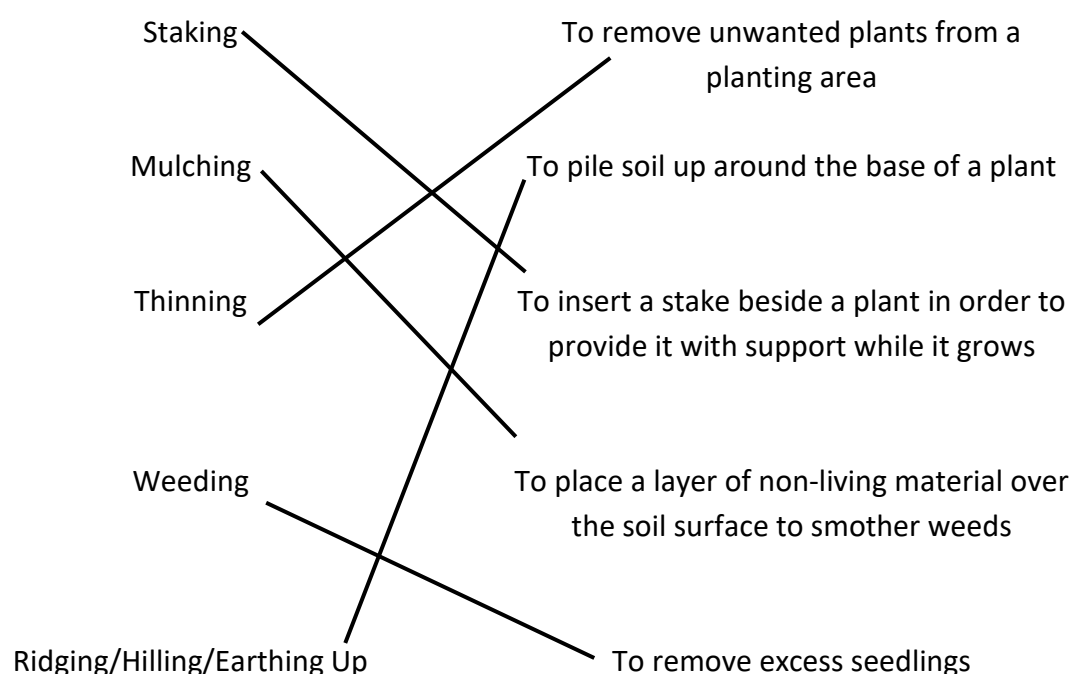
Problem Solving Activity

1. Tell trainees to work individually on **Topic 2.1 Task 2** in their manuals. They must match the crop maintenance practice to its definition by drawing a line between the practice and the definition.

Answers:

Crop Maintenance Practice

Definition



2. Verify their answers using the key above.
3. Now tell trainees to work with a partner to predict which tools they will need for each practice by writing them into the chart below under “Tools Needed.” Sample chart below.

Crop Maintenance Practice	Tools Needed	Types or Methods
Staking		
Mulching		

Thinning		
Weeding		
Ridging/Hilling/Earthing Up		

4. With their partners, tell trainees to read through **2.1 Key Facts** and do the following:
 - ✓ Check or correct the **Tools Needed** for each practice in the chart above.
 - + Add the **Types or Methods** for each practice in the chart above.



Guided Practice Activity

1. Separate trainees into five groups and assign each group one of the crop maintenance practices: mulching, weeding, thinning, ridging/hilling, and staking. Direct them to **Topic 2.1 Task 3** in their manuals for this activity's instructions.
2. With their groups, instruct trainees to use the resources available to them (textbooks, other trainers or teachers, the internet) to do further research on their assigned crop maintenance practice. They should collect information on the following:
 - a. Crops that the maintenance practice is used for.
 - b. How often the practice is performed.
 - c. The advantages and the disadvantages of the practice.
 - d. Any other information you believe is important about this practice.
3. Then, tell trainees to supplement their research by going into the community and interviewing a crop farmer.
 - a. Ask them about how they perform your assigned crop maintenance practice, including the tools they use and where they buy the tools from.
 - b. Ask them to confirm or explain any of the information from your research and/or **2.1 Key Facts** for their particular farm.
 - c. Ask them what else they do to maintain and protect the crops they are growing. How do they provide them with water? How do they protect them from getting eaten by animals?
4. Next, each group must create a presentation of the information from **2.1 Key Facts**, **2.2 Key Facts**, their independent research, and their field visit to a farm. Tell them to use the classroom flipchart or blackboard. Make sure each group member is given the opportunity to speak.

5. Groups will then take turns presenting their findings to the rest of the class. After their presentations, encourage the audience to ask questions and the groups to answer them to their best of their ability.



Application Activity

Organise a visit to a local crop farm with your class. Confirm that the farmer or another worker is available to give a tour of the crop field and answer questions, specifically about fencing and irrigation.

1. Tour the farm with the farmer or another worker.
2. Tell trainees to identify the fencing and irrigation systems in place. Encourage them to ask the farmer why he or she chose this particular system and its challenges. They should note the information in the chart (sample below), found in **Topic 2.1 Task 4** of their manuals.

	Fencing	Irrigation
Type/Method		
Reason		
Challenges		

3. Encourage the trainees to ask the farmer any other questions regarding crop maintenance practices.
4. After the field visits, discuss with the class:
 - a. What did you learn?
 - b. What surprised you?
 - c. What do you still need information about that is not in **Key Facts 2.2**?
5. Answer any questions trainees may have regarding maintenance methods of food crops, irrigation systems and fencing options.



Points to Remember

- Compare the different methods for each maintenance practice before performing them.
- Consider the effects of the environment on crop growth and how maintenances practices address these environmental factors, such as rainfall.



Formative Assessment

Match the type/method to its definition by drawing a line.

Answers:

1. Mulch

Type	Definition
Live	Made of cut grass or vegetable waste
Plastic	Plant directly in the soil of an existing cover crop
Organic	Suppresses weeds and conserves moisture from the soil

2. Weeds

Type	Definition
Perennial	Completes life cycle in one year
Annual	Completes life cycle in two seasons
Biannual	Completes life cycle after more than two years

3. Weed Control

Method	Definition
Chemical	By hand or using a machine
Mechanical	Uses organic material or crop rotation method
Natural	Uses herbicide

4. Irrigation

Type	Definition
Basin	Small channels carry water down the land slope between the crop rows
Furrow/Flood	Water drips slowly onto the soil through emitters or drippers located close to the plants
Drip	Water distributed by gravity flow across the field
Centre Pivot	Build embankments or barriers around flat areas of land, then flood flat areas with water
Sprinkler	One sprayer is connected to a mechanism that rotates in a circle
Surface	Water is distributed through a system of pipes then sprayed into the air

Write answers to the following questions.

5. What are two of the advantages of earthing up/ridging/hilling?

Possible Answers: Stabilizes the stems of crops and protect them from wind; promotes plant growth; supports the base of the plant and allows for the formation of a better root system; provides proper water drainage

6. What are the purposes of the following crop maintenance practices?

Answers:

- a. Fencing: To protect crops from animals by keeping them out of the crop area
- b. Thinning: To remove excess growing seedlings
- c. Staking: To provide support to the plant/crop while it grows

① Further Information for the Trainer

- 1. Acquah, G. (2005). *Principles of crop production: Theory, techniques and technology*. Upper Saddle River: Pearson Prentice Hall.
- 2. Fences for the Farm:
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_023913.pdf

Learning Outcome 2.2: Assist with managing pests and diseases

	Objectives: By the end of the learning outcome, trainees will be able to: - Identify pest symptoms based on visible damages on different parts of the plant - Identify diseases symptoms on different parts of the plant - Explain and differentiate between different types of pest damages - Describe and follow pesticide preparation, application, and safety procedures
	Time Required: 8 hours
	Learning Methodology: Brainstorming, interviewing, field visit, demonstration, group discussions
	Materials Needed: Standard training materials – flip chart, markers, tape, A4 paper
	Preparation: ☐ Organise a visit to a local crop farm. Confirm the farmer or another worker is available to give a tour of the field and answer questions about pest and disease control. ☐ Organise a visit to the school farm. Identify plots presenting symptoms/damages of pests and diseases in advance and make arrangement to enable trainees to visit and practice in those plots.
	Cross Cutting Issues: ✓ Environment and sustainability: Emphasize the need to protect the environment especially during disposal of pesticide containers. ✓ Standardisation culture: Encourage proper application and dosage measurement of pesticides.
	Prerequisites: ▶ None

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe pests and diseases symptoms	1. Identify damages based on pest and disease symptoms	1. Detail-oriented
2. Explain the different types of damages due to pests	2. Differentiate between pest damages to identify pest types	2. Diligent
3. Describe pesticide preparation and safety procedures	3. Apply pesticides to control pests and diseases in food crops by following instructions	3. Committed



Steps:



Getting Started: What do we know and where are we going?

1. Assign trainees to a partner and direct them to **Topic 2.2 Task 1** in their manuals. With their partner, tell them to do the following:
 - a. In your own words, define the terms “pests” and “diseases.”

Pests:

Diseases:

- b. Brainstorm different pests and diseases that might affect plants or crops. Sample chart below:

Pests	Diseases

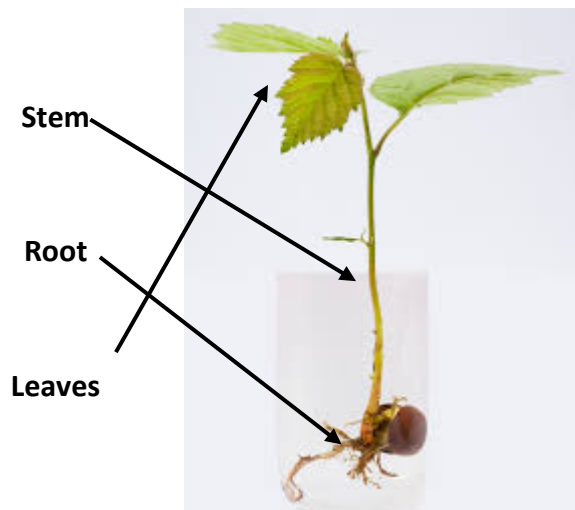
- c. Discuss your own experiences with pests and diseases while growing plants or crops.
2. Encourage trainees to share their ideas with the rest of the class. Allow an open and creative discussion. Be sure to mention or confirm that **pests** are small bugs or insects that eat or destroy crops, while **diseases** are harmful bacteria or viruses that kill crops.

3. Facilitate a discussion on how pests and diseases affect plant health. After a fruitful discussion, note that pests and diseases negatively affect plant health. They can damage a plant's leaves, stem, and/or roots, and eventually kill it.
4. Explain that this topic will go into more detail about pests and diseases and how to manage them. Refer trainees to the Key Competencies table and review together.



Problem Solving Activity

1. Ask trainees to turn to **Topic 2.2 Task 2** in their manuals and identify the stem, root, and leaves of the plant below by labelling each part.



2. Confirm their answers using the key above.
3. Tell trainees to complete the following with a partner:
 - a. Describe the shape, size, colour, and other features of what you see.



Figure 1



Figure 2



Figure 3



Figure 4

- b. Fill out the following chart based on your discussion.

Possible Answers are included in *italics* below.

	Shapes	Size	Colour	Other Notes
Figure 1	<i>Round and other shaped holes</i>	<i>Mostly small, throughout the leaf</i>	<i>Brown edges</i>	
Figure 2	<i>Round bugs</i>	<i>Small</i>	<i>Light and dark brown</i>	<i>Underneath the leaf, clustered together</i>
Figure 3	<i>Leaves are curled downward</i>	<i>Shrunkened in</i>	<i>Yellow, light brown</i>	
Figure 4	<i>Drooping down</i>	<i>Shrunkened</i>	<i>Dark brown, black</i>	<i>Mostly dead, falling down</i>

- c. Do you think each image shows damages caused by pests or diseases? Why?

Answers may vary and either could be correct in most cases with an explanation. Except *Figure 2*, which is clearly pests.

4. Bring the class together and do the following:

- Encourage trainees to share and compare their ideas for **Question 3**. Supplement with the **Possible Answers** above and correct major errors where needed.
- Discuss: How can we prevent pests and diseases from affecting plant health?
Possible Answers: Using pesticides/chemicals.

5. As a class, read through **2.3 Key Facts**. As they read, tell trainees to do the following:

- ❖ Star the symptoms that correspond with the images from **Question 3**.
- ✓ Check or tick any symptoms that you can imagine or have seen before.
- Circle any symptoms that you cannot imagine or have not seen before.

6. After reviewing **2.3 Key Facts**, tell trainees to write answers to the following questions:

- What are the types of pest mouth parts that cause damages?
- What are the differences between them?



Guided Practice Activity

- Match the symptom to its definition and its image found in **Topic 2.2 Task 3**.

Answers are drawn in below.

Symptom	Definition	Image
Wilting	Dead areas, usually on trees	
Cankers	Death of cells or tissue due	
Galls	Abnormal change in form or shape	
Necrosis	To become limp or weak; to droops	
Distortion	Swellings or growths	

¹ Simak, E. (n.d.). *Canker on sycamore* [Photograph]. Geograph. <https://www.geograph.org.uk/photo/6333990>
License: <https://creativecommons.org/licenses/by-sa/2.0/legalcode>

2. Bring the class to the school farm and tell them to do the following in small groups. Monitor them as they work and correct any errors.
 - a. Observe the plants/crops.
 - b. Identify any damage to the leaves or stems.
 - c. Identify the specific symptom present and predict if it was caused by pests or a disease.

3. After the visit to the school farm, tell trainees to work with their small groups to do the following:
 - a. Discuss how pests and diseases could be prevented on the farm.
 - b. Discuss how pests and diseases could be treated on the farm.
 - c. Read through **2.4 Key Facts**



Application Activity

Organise a visit to a local farm with plants/crops. Confirm that the farmer or another worker will be available to answer questions about pests and diseases that affect crops/plants and to give a tour of the field.

1. Before visiting the farm, direct trainees to **Topic 2.2 Task 4** in their manuals. In small groups, tell them to create interview questions for the farmer. They should write the questions in the chart (sample below). The questions should address the following points. They can also create a question on a topic of their choice.
 - a. Common pests
 - b. Common diseases
 - c. Disease and pest prevention and treatment methods
 - d. Advice

Questions	Answers

2. Upon arriving to the farm, instruct trainees to take turns interviewing the farmer using the questions they created with their groups. Monitor them so that they do not ask a question again if it has already been asked by another group. They should write the farmer's answers in the chart above.

3. After interviewing the farmer, take a tour of the farm. Instruct trainees to:
 - a. Identify any plants/crops with damages.
 - b. Determine the symptoms and if they were caused by pests or diseases.
 - c. Confirm your observations with the farmer.
4. Then, have trainees observe and assist the farmer with disease and pest treatment methods.
5. After the visit, facilitate a class discussion:
 - a. What did you learn?
 - b. What surprised you?
 - c. What do you need more information on?



Points to Remember

- It is important to wear protective equipment when handling and spraying pesticides to avoid potential chemical hazards.
- Clean water and a bar of soap must also be readily available in case a person's skin is contaminated with chemical spillage. A person must also wash up after handling the chemicals.
- Always remember to safely dispose containers of pesticides following label recommendations.



Formative Assessment

Circle the correct answer to each question.

Answers are in bold.

1. Which pesticide application method is most commonly used in Rwanda on food crops?
 - a. Fumigation
 - b. Baiting
 - c. **Spraying**
 - d. Dusting

2. Which symptom involves the death of plant cells or tissues?
 - a. **Necrosis**
 - b. Wilting
 - c. Distortion
 - d. Root Knots

3. Which of the following is **NOT** a consideration for selecting pesticide tools and equipment?
 - a. Size of the land
 - b. Frequency of application
 - c. **The temperature in Kigali**
 - d. Cost of equipment and application

Write answers to the following questions. Answers/Possible Answers included below.

4. What are the two types of pest damages? Circle the one that is more obvious or clear to identify.
 - a. Biting/Chewing
 - b. Piercing/Sucking

5. Name two symptoms of pest damages for each part of the plant. Do not list any symptom twice.

Leaf	Stem	Root
Wilting, leaf spots, mosaic, yellowing, distortion, little leaves, galls, drying/necrosis/blight	Wilting, witches' broom, cankers, yellowing, galls	Wilting, water moulds, distortion, drying/necrosis/blight

6. Name two symptoms of disease damages for each part of the plant. Do not list any symptom twice.

Leaf	Stem	Root
Stunting, spots, galls, elongation, water soaked, discolouration, ring spots	Galls, elongation, blight, damping off	Galls, root knot, cankers, edema, wilting, darkening, lesions, rots

Further Information for the Trainer

1. Recognise pests, diseases and weeds on crops:
https://www.agriseta.co.za/downloads/LearningMaterial/116204_LG.pdf
2. Pest, disease and weed management:
https://www.agriseta.co.za/downloads/LearningMaterial/116124_LG.pdf
3. Crop pests and diseases:
<http://africasoilhealth.cabi.org/wpcms/wp-content/uploads/2015/09/519-ASHC-manual-English.pdf>
4. Different Pests Cause Different Damage:
<http://gardeningsolutions.ifas.ufl.edu/care/pests-and-diseases/pests/management/different-pests-different-damage.html>
5. Diseases and Disorders:
<https://content.ces.ncsu.edu/extension-gardener-handbook/5-diseases-and-disorders>
6. Plant Diseases:
<http://gardeningsolutions.ifas.ufl.edu/care/pests-and-diseases/diseases/>

Learning Outcome 2.3: Use fertilisers on food crops

	Objectives: By the end of the learning outcome, trainees will be able to: - Identify and select fertilisers following recommendations. - Calculate fertiliser rates considering the plot size and nutrients needed. - Apply fertilisers following the recommended application methods and timing.
	Time Required: 8 hours
	Learning Methodology: Brainstorming, group discussions, field visit, interview, demonstration, presentation
	Materials Needed: Standard training materials – Flipchart, markers, tape, A4 paper Sample mineral fertilisers – NPK, DAP, and/or Urea Sample organic fertilisers (or images) – manure, compost Measurement tools – calculators
	Preparation: ☐ Perform and understand fertiliser rate calculation before class. Consult other resources, if needed. ☐ Collect and prepare sample mineral and organic fertilisers. ☐ Prepare materials for independent research task, such as textbooks and computers/internet. ☐ Organise a visit to a local food crop farm. Confirm that the farmer is available to answer questions, demonstrate fertiliser application, and guide trainees in applying fertiliser.
	Cross Cutting Issues: ✓ Environment and sustainability: Acknowledge the relationship between the natural soil and the fertilisers and/or soil amendments added. ✓ Standardisation culture: Emphasize the importance of calculating the correct amount of fertiliser needed rather than applying fertiliser randomly.
	Prerequisites: ▶ Basic Algebra

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe the different types of fertilisers	1. Choose fertilisers following recommendations	1. Detail-oriented
2. Describe techniques for applying fertilisers	2. Apply fertilisers using recommended techniques	2. Methodical
3. Explain the steps needed to calculate the amount of fertiliser needed for a given field area	3. Calculate the amount of fertiliser needed for a given field area	3. Problem-solver



Steps:



Getting Started: What do we know and where are we going?

1. Ask trainees to open to **Topic 2.3 Task 1** in their manuals and brainstorm answers to the following questions with a partner:
 - a. What is a fertiliser?
 - b. When are fertilisers used?
 - c. Why are fertilisers used?
 - d. What are the differences between crops that have been fertilized compared to crops that have not been fertilized?
2. Ask trainees to share their ideas with the rest of the class. If needed, explain that fertiliser is material (natural or manufactured) that is added to plant soil to improve the supply of nutrients in the soil and increase plant growth.
3. Encourage volunteers to share any experiences they or someone in their community have had using fertilisers on their food crops.
4. Explain that this topic will look more in depth at fertilisers – different types and how to apply them. Refer trainees to the Key Competencies table and review it together.



Problem Solving Activity

1. Direct trainees to **Topic 2.3 Task 2** in their manuals and separate them into small groups. With their groups, tell them to predict the difference between the following concepts. One person in each group should write down the ideas.
 - a. Fertilisers **vs.** Soil Amendments
 - b. Organic **vs.** Mineral (Fertilisers or Amendments)
 - c. Manure **vs.** Compost
 - d. Simple/Single/Straight Fertilisers **vs.** Compound/Mixed Fertilisers
2. Tell trainees to select one person from their groups to share their group's ideas with the rest of the class. After each group has shared, have them compare their responses by discussing the following questions:
 - a. How are your ideas similar?
 - b. How are your ideas different?
 - c. What did you base your ideas on?
 - d. What additional factors should your group consider?
3. Next, instruct trainees to read **2.5 Key Facts** with their groups.
4. Tell trainees to identify the terms from **Question 1** and explain the differences by writing them below using **2.5 Key Facts**. They may work with their group members, if desired.
 - a. Fertilisers **vs.** Soil Amendments
 - b. Organic **vs.** Mineral (Fertilisers or Amendments)
 - c. Manure **vs.** Compost
 - d. Simple/Single/Straight Fertilisers **vs.** Compound/Mixed Fertilisers
5. Facilitate a class discussion on the following, using **2.5 Key Facts** for guidance.
 - a. What are the different types of fertiliser application methods? Which do you think is best and why?

Answer: Deep soil, broadcasting, band placement, and liquid application. Answers may vary for the best. Any answer may be accepted as long as the trainee(s) can defend their choice.

- b. How do you know a plant does not have enough nutrients? Why should you be cautious when making this assessment?

Answer: A plant will show signs of nutrient deficiencies, such as stunted growth, chlorosis, interveinal chlorosis, purplish-red colouring, or necrosis. You should be

cautious because many signs/symptoms indicate a deficiency of several nutrients, not just one.



Guided Practice Activity

1. Direct the trainees to **Topic 2.3 Task 3** in their manuals and separate them into small groups. Assign each group a food crop in Rwanda: maize, wheat, rice, beans, bananas, cassava, potatoes, coffee, and/or any other major food crops in Rwanda.
2. Explain to the trainees that they will conduct independent research on their assigned food crop. They should consider the following resources while conducting their research:
 - a. The internet
 - b. Books
 - c. Trainer and/or other staff at school
 - d. Community members, such as shop keepers and farmers
3. Emphasize that their research should address *at least* the following points about their assigned food crop:
 - a. The type of fertiliser used for this crop
 - b. Where this fertiliser comes from/is bought locally
 - c. When this fertiliser is used on the crop
 - d. Application method of fertiliser on the crop
4. After researching, tell trainees to collaborate with their groups to create a presentation on their food crop for the rest of the class. Be sure that they have verified all the information collected during research.
5. Facilitate presentations by each group to the rest of the class. Make sure trainees listen to the presentations of other groups. They should record the information learned using the chart (sample below):

Food Crop	Type of Fertiliser Used	Application Method	Application Timing	Other Notes

6. After the presentations, facilitate a class discussion of the following questions:
 - a. How do you know the amount of fertiliser to use?

- b. Which factors or variables should you consider when calculating the amount of fertiliser needed?

Answers may vary, but the general conclusion should be that the fertiliser amount need to be calculated. Some possible factors to consider are the percentage/concentration of nutrients in the fertiliser, the nutrients needed, and the size of the crop field.

7. Read through **2.6 Key Facts** as a class. Tell trainees to verify their predictions from **Question 6** with the information given.
8. Instruct try a practice problem individually using the formula and example from **2.6 Key Facts** to guide you:
- a. You have the NPK 17 17 17 fertiliser. You want to apply it to the field at a rate of 5 kg of **potassium** per 1000 m². The area of your field is 10,000 m², or 1 hectare (ha). How much fertiliser is needed to cover the entire field?

Answer:

1. Nutrient Rate = 5 kg/1000 m²
2. Amount of Nutrient desired
= 5 kg / 1000 m² * 10,000 m²
= 0.005 * 10,000
= 50 kg of potassium
3. Nutrient desired / Concentration (17% potassium = 0.17)
= 50 kg / 0.17
= **294 kg of NPK 17 17 17**

9. Give trainees sufficient time to struggle with the problem. Then, tell them to compare their answers with a partner. Finally, verify their answers using the explanation above. Also, ask them to calculate how much fertiliser would be necessary if the rate of 1 kg of phosphorous per 1000 m² was required. After letting trainees work on it, ask for a volunteer to demonstrate the calculation on the board. Guide as necessary and give additional problems if there is time.

Answer:

1. Nutrient Rate = 1 kg/1000 m²
2. Amount of Nutrient desired
= 1 kg / 1000 m² * 10,000 m²
= 0.001 * 10,000
= 10 kg of phosphorous

3. Nutrient desired / Concentration (17% phosphorous = 0.17)
 = 10 kg / 0.17
 = **58.8 kg of NPK 17 17 17**



Application Activity

Organise a visit to a local food crop farm with your class. Confirm in advance that the farmer will be available to answer questions about and give a demonstration on applying fertiliser to food crops. Ask if it is possible for trainees to also assist the farmer with applying fertiliser.

1. Before visiting the farm, ask trainees to open their manuals to **Topic 2.3 Task 4**. Separate them into small groups and instruct them to prepare questions to interview the farmer with regarding fertiliser types, application methods, application timing, and rates. They should create 6 questions and write them below:

- | | |
|----|----|
| 1. | 4. |
| 2. | 5. |
| 3. | 6. |

2. Tell trainees to select one representative from their group to share their questions with the class. As a class, vote on the best 6 questions and tell trainees to write them into the chart (sample below):

Questions	Answers

3. Upon arriving to the farm, facilitate an interview between the farmer and the trainees. Tell trainees to write the farmer's responses in the chart.

4. Ask the farmer to designate one crop, one type of fertiliser, the approximate area of the crop's field, and the nutrients needed. Using this information, trainees should calculate the amount of fertiliser needed. Monitor and assist them with the calculations. Once they have finished, verify their answers.
5. If possible, have trainees observe and assist the farmer in applying fertiliser to their farm.
6. After the visit, facilitate a class discussion which addresses the following questions:
 - a. What did you learn?
 - b. What surprised you?
 - c. What information do you still need about food crop fertilisers?



Points to Remember

- Always wear personal protective equipment while handling fertilisers.
- If possible, it is best to test the soil in order to know the right recommendation of fertilisers because deficiency symptoms sometimes show the deficiency of more than one nutrient.
- Fertilisers directly improve the supply of nutrients in the soil, while soil amendments indirectly improve plant growth.
- Consult fertiliser recommendations provided by researchers and experts.



Formative Assessment

Write answers to the following questions.

1. What is the difference between organic and mineral fertilisers?

Answer: Organic fertilisers do not use chemicals and are made from living materials, such as animal faeces or compost. They are natural. However, mineral fertilisers are not natural; they are manufactured and focus on supplying a concentration of one or more of the nutrients—nitrogen, phosphorous, potassium.

2. Name and explain 2 types of fertiliser application methods.

Possible Answers:

- a. Deep Soil: Mix well into soil before planting
 - b. Broadcasting: Spread over entire soil surface evenly and uniformly
 - c. Band Placement: Place into soil close to the seed or plant
 - d. Liquid: Dissolve into water used for irrigation
3. Calculate the amount of NPK 17-17-17 needed to apply to a field of rice that is 30 m x 50 m if the recommended rate is 3 kg of nitrogen per 1,000 m².

Answer:

1. Nutrient Rate = 3 kg/1,000 m²
2. Amount of Nutrient desired
= 3 kg / 1,000 m² * 1,500 m²
= 0.003 * 1,500
= 4.5 kg of nitrogen
3. Nutrient desired / Concentration (17% nitrogen = 0.17)
= 4.5 kg / 0.17
= **26 kg of NPK 17 17 17**

Complete the following sentences:

4. Signs of nutrient deficiency include stunted growth, **chlorosis**, interveinal chlorosis, purplish-red **colouring**, and necrosis.
5. The band placement application method involves placing fertiliser into the soil **close** to the seed or plant and is used for **small** quantities of fertiliser.
6. The primary nutrients for plant growth are nitrogen (N), **phosphorous** (P), or potassium (K).



Self-Reflection

1. Ask learners to re-take the self-assessment at the beginning of the unit. They should then fill in the table in the Trainee's Manual to identify their areas of strength, areas for improvement and actions to take to improve.
2. Discuss trainees' results with them. Identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Further Information for the Trainer

1. McCauley, A., Jones, C. and Jacobsen, J. (2011). Nutrient Management Module No. 9: Plant Nutrient, Functions and Deficiency, and Toxicity Symptoms. Montana State University. Retrieved from <https://core.ac.uk/download/pdf/6522740.pdf>.
2. MINAGRI, 2011. Farmer's diary.
3. MINAGRI, 2018. Farmer's diary.
4. Fertilisers vs. Soil Amendments:
<http://ipm.ucanr.edu/TOOLS/TURF/SITEPREP/amenfert.html>
5. Four Methods For Applying Fertilisers:
<https://homeguides.sfgate.com/four-methods-applying-fertilisers-25517.html>
6. Fertiliser Calculations:
<https://extension.psu.edu/calculations-used-to-determine-the-amount-of-fertiliser-needed-to-treat-turf>
7. Fertiliser Statistics Overview: Rwanda 2013-2017:
<https://africafertiliser.org/blog-post/fertiliser-statistics-overview-rwanda-2013-2017/>

Learning Unit 3: Assist with harvesting activities for food crops



Learning Outcomes

By the end of the Learning Unit, trainees will be able to:

- 3.1** Determine maturity indices for food crops
- 3.2** Perform harvesting operations
- 3.3** Pack and transport food crops produce

Learning Unit 3 Self-Assessment

- 1.** Ask trainees to look at the illustration above (in their Trainee Manuals) and discuss what they see. What topics do they think this unit will include based on the picture? After some brainstorming, share the main topics.
- 2.** Ask trainees to fill out the self-assessment at the beginning of the unit in their Trainee Manuals. Explain that the purpose of the self-assessment is to become familiar with the topics in the unit and for them to see what they know or do not know at the beginning. At the end of the unit, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas that need improvement and actions to take. The self-assessment is not a test!

Learning Outcome 3.1: Determine maturity indices for food crops



Objectives: By the end of the learning outcome, trainees will be able to:

- a. Describe and identify the maturity indices of a given food crop
- b. Identify the different growth stages of food crops
- c. Measure maturity indices to determine the maturity of food crops



Time Required: 6 hours



Learning Methodology: Brainstorming, group discussions, field visit, farm tour, photo analysis



Materials Needed:

- **Standard training materials** – flip chart, markers, tape, A4 paper
- **Visual/audio materials** – internet, computer, projector
- **Pictures** – photos of food crop plants at different growth stages



Preparation:

- ☐ Research, download, and prepare pictures of food crop plants at different growth stages. Focus on finding pictures that show foods that are either mature or not yet mature.
- ☐ Organise a visit to a local food crop farm. Confirm that the farmer will be available to give a tour of the field and answer questions about measuring maturity indices.



Cross Cutting Issues:

- ✓ **Environment and sustainability:** Acknowledge that environmental conditions affect crop growth and capacity to mature/ripen.
- ✓ **Gender and inclusion:** Ensure groups are made with a gender balance.



Prerequisites:

- ▶ Learning Units 1 and 2

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe maturity indices for food crops	1. Identify maturity indices for a given food crop	1. Proactive
2. Explain the growth stages for a crop	2. Decide when a crop has entered its maturity or ripening stage	2. Accurate
3. Describe the specific maturity indices for different crops	3. Determine if different crops have reached maturity	3. Detail-oriented



Steps:



Getting Started: What do we know and where are we going?

1. Ask trainees to open their manuals to **Topic 3.1 Task 1** and individually reflect on a time they tried to grow something or imagine they are growing a food crop. Tell them to write their answers below each question.
 - a. How do you know when the fruit, vegetable, or wheat is ready to be harvested?
 - b. What factors do you consider when determining if it is time to harvest? Brainstorm as many as you can.
 - c. How can we measure these factors? What tools might we use?
2. Tell trainees to share their ideas with a partner and discuss their answers:
 - a. How are they similar?
 - b. How are they different?
3. Facilitate a class discussion on the concept of “maturity.” Explain that maturity is the state of being fully developed. Note that maturity is an indication that the crop is ready to be harvested.
4. Explain that this topic will focus on determining when a crop is mature and ready to harvest. Review the Key Competencies table together.



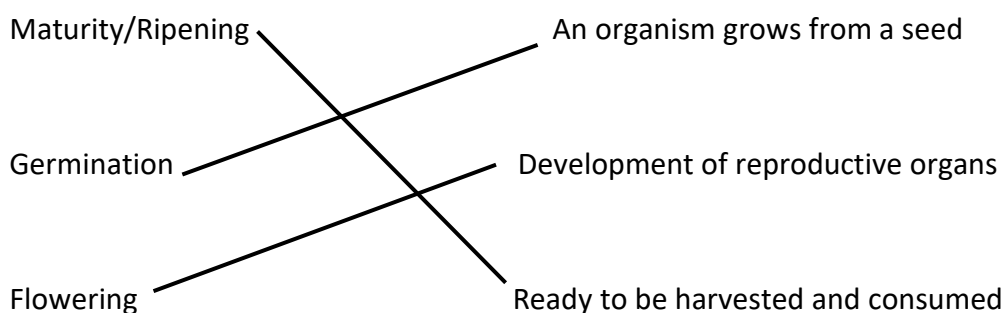
Problem Solving Activity

1. Direct trainees to **Topic 3.1 Task 2** in their manuals. Explain that “maturity indexing” is the process of monitoring the physiological development of crops. Tell trainees to consider the following scenarios and discuss their predictions with a partner:
 - a. What might happen if you harvest a crop too soon?
 - b. What might happen if you harvest a crop too late?
2. Tell trainees to match the crop growth stage to its definition by drawing a line between them. Then, put them in the correct order. Encourage them and explain that they can use prior knowledge and experience to discover the answers.

Answers are drawn and written in below.

Growth Stage

Definition



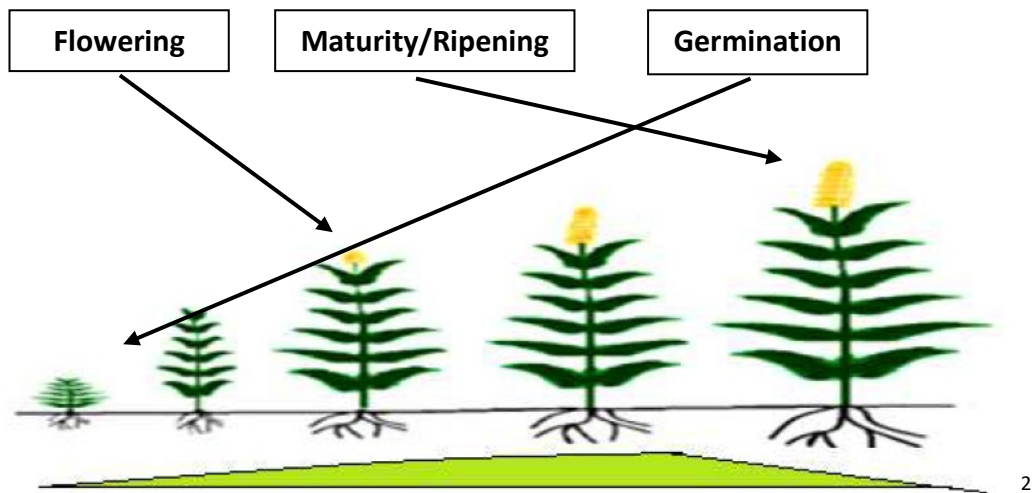
Growth Stages:	1. Germination	2. Flowering	3. Maturity/Ripening
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3. Instruct trainees to read through **3.1 Key Facts** with their partner and do the following. Monitor the groups as they work and clarify the information in **3.1 Key Facts** as needed.
 - a. Compare the factors they brainstormed in **Task 1** to the physical features listed in **3.1 Key Facts**.
 - ✓ Check or tick the factors/features you guessed correctly.
 - ❖ Star the factors/features you had not considered.
 - b. Compare your responses to **Question 2** to the information given in **3.1 Key Facts**.
 - c. Discuss any questions you may have about the key facts. Ask the trainer for explanations and assistance.



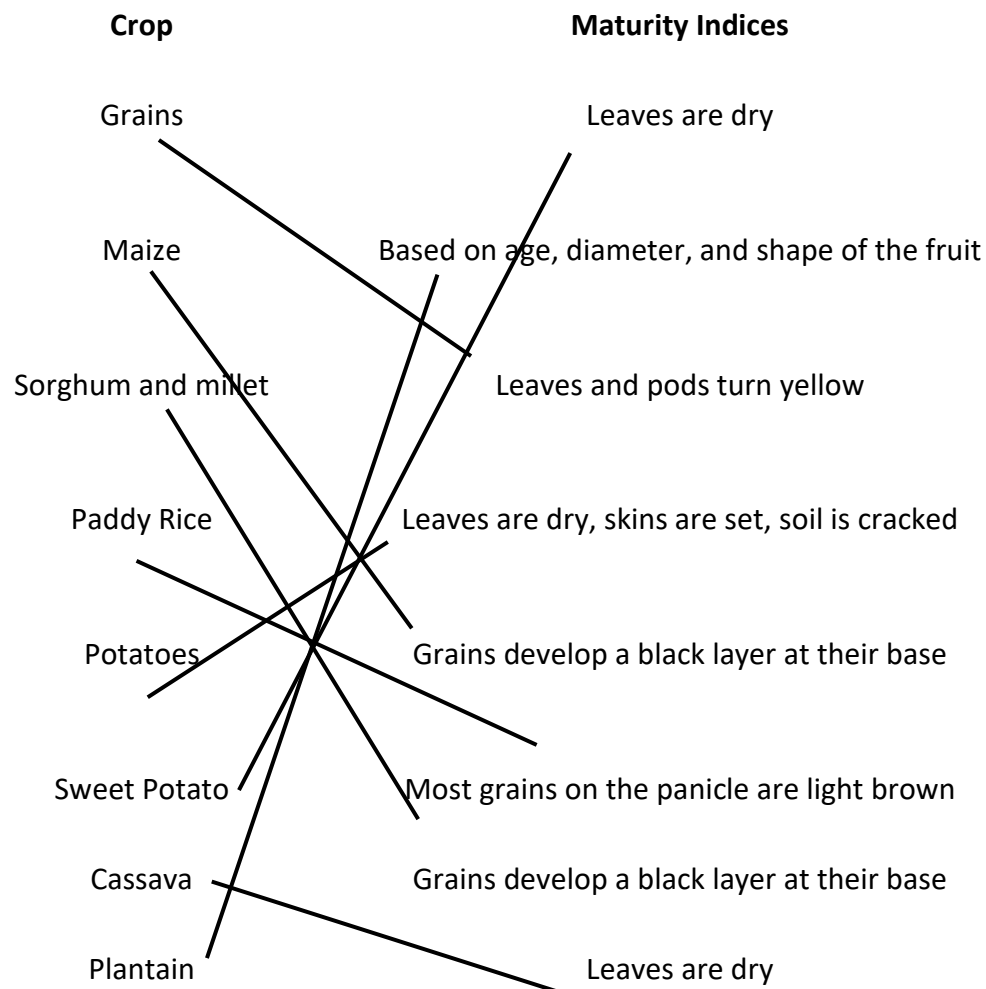
Guided Practice Activity

1. Ask trainees to draw an arrow connecting the growth stages to their corresponding images found under **Topic 3.1 Task 3** in their manuals, using the descriptions from **3.1 Key Facts** to guide them.



² Leghari, S. J. (2018, July 20). *Uited*. Wikimedia Commons. <https://commons.wikimedia.org/wiki/File:Uited.png>
License: <https://creativecommons.org/licenses/by-sa/4.0/legalcode>

2. Tell trainees that for this exercise, they should NOT refer to **3.1 Key Facts**. Tell them to match the crop to its maturity index by drawing a line between them. **Answers** have been drawn in below.



3. First, tell trainees to compare their responses with a partner. Then, they should verify their responses with the information in **3.1 Key Facts**.
4. Display photos of food crops during different growth stages. Instruct trainees to determine if each crop is mature or not yet mature. Be sure that they defend their responses using evidence from **3.1 Key Facts** or other sources.



Application Activity

Organise a visit to a local food crop farm. Confirm that the farmer will be available to give a tour of the field and answer questions about measuring maturity indices.

1. Take a tour of the field.
2. While you are touring the field, tell trainees to determine approximately which growth stage the crops are in. Are they mature and ready to be harvested? They should be sure to give evidence based on their observations. Tell trainees to note their findings in the chart (sample below):

Crop	Growth Stage	Mature or Not Yet Mature?	Evidence

3. Tell trainees to verify their observations with the farmer.
4. After the tour, encourage trainees to ask the farmer any remaining questions they have about maturing indexing for crops.
5. After the visit, facilitate a class discussion:
 - a. What did you learn?
 - b. What surprised you?
 - c. What do you still need more information on?



Points to Remember

- Harvesting too soon before or too late after maturity may negatively affect the quality of the crop and result in financial losses
- The black layer that forms at the base of maize, sorghum, and millet can be seen by removing the grains from the cob and scraping the base with your fingernail.



Formative Assessment

Write answers to the following questions.

1. What are two physical features that indicate maturity and how are they measured?

Possible Answers:

Physical Feature	How to Measure
Size	By sight and weight
Shape	By dimensions and ratio charts
Colour	By comparing to visual colouring charts and observing light reflections
Surface	By sight
Abscission	By sight

2. What is the purpose of maturity indexing?

Answer: To determine if a crop is ready to be harvested and eventually sold/consumed

3. What are the maturity indices for each of the following crops?

Answers:

1. **Potato** = Leaves are dry, skins are set, soil is cracked
2. **Cassava** = Leaves begin to dry
3. **Maize** = Plant has become light brown, the grain is hard, and/or a black layer forms at the base of grains

Circle the correct answer for each question. **Answers are in bold.**

4. What is the maturity index for sorghum and millet?

- a. **Grains develop a black layer at the base**
- b. Leaves are dry
- c. Leaves turn yellow
- d. Soil is cracked

5. Which crop's maturity index is when the leaves and pods turn from green to yellow?

- a. Sweet potato
- b. Rice paddy
- c. **Grains**

- d. Cassava
6. How do you measure the colour of a plant to determine its maturity index?
- a. By sight
 - b. By holding it
 - c. By eating it
 - d. **By comparing it to visual colour charts**



Further Information for the Trainer

1. The Stages of the Flower Life Cycle:
<https://www.avasflowers.net/the-stages-of-the-flower-life-cycle>
2. Postharvest Technology of Horticultural Crops by Adel A. Kader, pages 56-59.

Learning Outcome 3.2: Perform harvesting operations

	Objectives: By the end of the learning outcome, trainees will be able to: - Select the appropriate materials, tools, and equipment for harvesting food crops. - Prepare the tools, materials, and equipment for harvesting food crops. - Describe the harvesting operations and their purposes.
	Time Required: 7 hours
	Learning Methodology: Brainstorming, group discussions, small group work, demonstration, field visit, interview
	Materials Needed: Standard training materials – flip chart, markers, tape, A4 paper Sample pictures – photos of harvesting operations/methods being done Audio/visual equipment – internet, computer, projector
	Preparation: ☐ Organise a visit to a local crop farm, preferably when some crops are mature and ready to be—or in the process of being—harvested. Confirm that the farmer is available to give a tour, demonstrate preparation methods, and answer questions about harvesting operations. ☐ Research and download photos and videos of the different harvesting operations for food crops.
	Cross Cutting Issues: ✓ Gender and inclusion: Consider gender balance when forming small groups. ✓ Environment and sustainability: During harvesting operations, emphasize the need to protect the environment, especially by recycling garbage and materials after use.
	Prerequisites: ▶ Learning Unit 3.1: Determine maturity index for food crops

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe the materials, equipment, and tools used for harvesting food crops	1. Select materials, equipment, and tools used for harvesting food crops	1. Attentive
2. Describe the preparation of tools, materials and equipment for harvesting food crops	2. Prepare tools, equipment, and materials for harvesting	2. Proactive
3. Describe various methods and operations for harvesting food crops	3. Choose the method for harvesting food crops	3. Methodical



Steps:



Getting Started: What do we know and where are we going?

1. Tell trainees to think about how farmers harvest food crops produce. Instruct them to open their manuals to **Topic 3.2 Task 1** and individually brainstorm answers to the following questions. They should write their answers.
 - a. What are materials, tools, and equipment used for harvesting?
 - b. What does it look like when farmers harvest crops? What are they doing with the materials, tools, and equipment?
2. Tell trainees to share and discuss their ideas with a partner.
 - ✓ Check or tick any answers that you both wrote.
 - + Add any answers that your partner wrote, but you did not consider.

3. Ask for volunteers to share their ideas with the rest of the class.

Answers may vary. Encourage an open and creative discussion between partners and as a full class. The correct answers will be revealed in **3.2 Key Facts**.

4. Explain that this topic will help prepare trainees for harvesting – the selection and preparation of materials and tools, as well as selecting the method for harvesting. Review the Key Competencies table together.



Problem Solving Activity

1. Tell trainees, using prior knowledge and experience, to match the tools, equipment, and materials to its image and its use by writing the corresponding letter (A, B, C) and numeral (i, ii, iii) into the chart found in **Topic 3.2 Task 2** in their manuals. **Sickle** has been done as an example.

Item	Image	Use
1. Sickle	E	ii
2. Machete	D	v
3. Knife	G	iv
4. Thresher	C	vi
5. Combine Harvester	A	iii
6. Forklift	B	i
7. Sack	F	vii

2. Have trainees, with a partner, do the following:
 - a. Discuss safety procedures someone should follow when using harvesting tools, materials, and equipment. Write two safety procedures:
 - i.
 - ii.
 - b. Discuss the terms “adjustment” and “calibration.”
 - i. What do you think they mean?
 - ii. Why do you think they are important for harvesting operations?

3. Now, tell trainees to read through **3.2 Key Facts** with a partner. As they read, they should do the following:
 - a. Verify their answers to **Question 1**. Walk around and confirm the images for them.
 - b. For **Question 2a**:
 - ✓ Check or tick the procedures that match the information given in **3.2 Key Facts**.
 - Circle the procedures that do not match the information given in **3.2 Key Facts**.
 - c. For **Question 2b**:
 - ❖ Star the terms adjustment and calibration.
 - Give an example of a machine that needs to be adjusted and calibrated. What aspects need to be adjusted? What needs to be calibrated?



Guided Practice Activity

1. Tell trainees to imagine they are growing maize at their farm. They need to select tools, equipment, and materials for harvesting the maize. Separate them into small groups and direct them to **Topic 3.2 Task 3** in their manuals. Instruct them to discuss and write answers to the following questions:

- a. What factors will you consider before selecting the tools, equipment, and materials?
Answer: Cost, size of land, harvesting method

- b. List the tools, equipment, and materials you will need.

Answers may vary and it will depend on the harvesting method. Most tools, materials, and equipment are necessary as long as the trainees can explain how and why they will use them.

- c. Before using the equipment, what three processes must be completed? Why are they important?

Answers:

- i. Cleaning: To prevent/decrease the risk of diseases, to prolong the lifespan of tools and equipment
 - ii. Adjustment: To ensure that the tools/equipment fit the needs of the user and the crop
 - iii. Calibration: To set the parameters so that the machine can be used properly
- d. What is the difference between manual and mechanical harvesting methods? Which do you think is better and why?

Answer: Manual methods use hands or hand-operated tools, while mechanical methods use mechanically-operated machines. Trainees may defend either method

as long as they give an explanation. More information on the advantages and disadvantages will be given in **3.3 Key Facts**.

2. Ask each group to share their ideas. Refer to the **Answers** above.
3. With their groups, tell trainees to read through **3.3 Key Facts**. Using the information in **3.2 and 3.3 Key Facts**, they should do the following:
 - a. Identify and write the advantages of manual and mechanical methods.

Advantages	
Manual	Mechanical
Effective for flattened, or lodged, crops	Low amount of labour needed

- b. Identify and write the disadvantages of manual and mechanical methods.

Disadvantages	
Manual	Mechanical
Labour-intensive	Expensive and difficult to get

Answers given above are from **3.3 Key Facts**. Additional ideas are welcome.



Application Activity

Organise a visit to a local crop farm, preferably when some crops are mature and ready to be—or in the process of being—harvested. Confirm that the farmer is available to give a tour, demonstrate preparation methods, and answer questions about harvesting operations.

1. Take a tour of the crop field.
2. Instruct trainees to determine which of the harvesting operations are taking place and note their observations under **Topic 3.2 Task 4** in their manuals.
 - a. Write a check or tick (✓) if an operation is happening on the farm.
 - b. Write an X if the operation is not happening on the farm.

Harvesting Operation	✓ or X	Tools, Equipment, or Materials Used

Reaping		
Threshing		
Cleaning		
Hauling		
Field Drying		
Stacking/Piling		
Bagging		

- After the tour, tell trainees to observe the farmer as he or she demonstrates how to clean, adjust, and calibrate a piece of equipment. If possible, facilitate the trainees as they take turns assisting the farmer in these processes.
- Finally, tell the trainees to ask the farmer the following questions, plus one of their own about harvesting operations. They should write their answers in the chart (sample below):

Questions	Answers
Where do you purchase your tools, equipment, and materials from?	
What is the most challenging part of harvesting at your farm?	
Your Question:	

- After the visit, display photos and videos of the different harvesting operations from **3.3 Key Facts**. Tell trainees to identify the specific operation. Then, have them discuss:
 - How are the pictures similar to what you observed at the local farm?

- b. How are they different?
- c. Why?



Points to Remember

- Always wear protective equipment when performing harvesting activities in food crops to avoid potential hazards.
- Proper harvesting operations improves crop yield and decreases damages and diseases.



Formative Assessment

Complete the following sentences. **Answers are in bold.**

1. **Hauling** occurs when the crop is moved to the threshing location.
2. Threshing is the process of separating the **grain** from the **straw** by beating the grain against a hard object.
3. Sickles, knives, and **machetes** are all used to cut crops.

Write answers to the following questions.

1. What is the difference between manual and machine harvesting methods?

Answer: Manual methods use hands or hand-operated tools, while mechanical methods use mechanically operated machines.

2. What is the purpose/importance of cleaning tools, equipment, and materials before using them?

Answer: To prevent and reduce the risk of diseases, and to extend the lifespan of the tools and equipment.

3. Which 2 operations are optional? What are the risks of doing them?

Answers:

1. Field Drying
2. Stacking/Piling

Risks: They can lead to decreased quality and increases losses



Further Information for the Trainer

1. Harvest Agricultural Crops:
https://www.agriseta.co.za/downloads/LearningMaterial/116111_LG.pdf
2. Crop Harvesting:
https://www.agriseta.co.za/downloads/LearningMaterial/116268_LG.pdf
3. Farm Management:
<https://www.farmmanagement.pro/calibrating-your-machines-accurately-for-harvest/>
4. Harvesting Processes:
<http://www.knowledgebank.irri.org/step-by-step-production/postharvest/harvesting>

Learning Outcome 3.3: Pack and transport food crop produce

	Objectives: By the end of the learning outcome, trainees will be able to: - Describe the methods used for packing crops after harvesting. - Identify and select the materials, tools, and equipment for transporting produce. - Determine the transportation method to use.
	Time Required: 7 hours
	Learning Methodology: Brainstorming, group work, field visit, interview, demonstration, presentation
	Materials Needed: Standard training materials – flip chart, markers, tape, A4 paper Sample pictures – images of the different materials, tools, and equipment needed for packing and transporting produce Audio/visual equipment – computer, internet, and projector to display images
	Preparation: ☐ Organise a visit to a local food crop farm at harvesting time. Confirm that the farmer will be available to answer questions, give a tour, and demonstrate how to pack the produce. ☐ Research, download, and prepare pictures of the different materials, tools, and equipment to display. ☐ Set up the audio/visual equipment before class.
	Cross Cutting Issues: ✓ Standardisation culture: Emphasize the need to identify high quality produce and remove damaged or disease produce during the packing process to guarantee a uniform product. ✓ Gender and inclusion: Consider gender balance when creating groups for Task 3.
	Prerequisites: ▶ Learning Topic 3.1 ▶ Learning Topic 3.2

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe the methods used for packing crops after harvesting	1. Perform packing of food crops	1. Methodical
2. Identify the materials, tools, and equipment for transporting produce	2. Select materials, tools, and equipment needed for transportation	2. Diligent
3. Explain the difference between manual and mechanical transportation methods	3. Determine the transportation method to use	3. Decisive



Steps:



Getting Started: What do we know and where are we going?

1. Ask trainees to turn to **Topic 3.3 Task 1** in their manuals. Explain that after harvesting food crops, they must be packed and transported to be sold. Tell trainees to discuss the following questions with a partner:
 - a. What materials are used for packing and transporting materials? List them below.
 - b. What tools are used for packing and transporting materials? List them below.
 - c. What equipment is used for packing and transporting materials? List them below.
 - d. Why is it important to handle produce with care when packing and transporting it?
2. Encourage trainees to share their ideas with the rest of the class. Tell them to add any materials, tools, and equipment to their lists that they did not include previously.

Answers will vary for questions a through c. Encourage trainees to be as creative as possible in their responses. Focus on their ideas for **question d**. After they have discussed, add that produce can easily become damaged during packing and transporting if they are not handled with care.

3. Explain that this topic will look at these packing and transporting questions in detail. Review the Key Competencies table together.



Problem Solving Activity

1. With your partner, brainstorm responses to the following questions found in **Topic 3.3 Task 2** in their manuals:
 - a. What are some challenges with packing food crops?
 - b. How can we address those challenges to ensure high quality products?
 - c. Packing can be done on the field or inside a shed. Which do you think is better? Why?
 - d. Based on your previous knowledge from **Topic 3.2**, what do you think is the difference between manual and mechanical transportation methods?

Answers will vary. Possible challenges: acquiring the materials, tools, and equipment, the cost of these items, rough roads, untrained workers, bad weather, poor handling, lack of space, need for special operations.

2. Tell trainees to read through **3.4 Key Facts** and do the following as they read:
 - ✓ Check or tick the materials, tools, and equipment that you correctly guessed in **Task 1**.
 - ❖ Star the advantages of field packing and packing in a shed.
 - Write the 3 important considerations to make when packaging food crops:
Answers:
 1. Handle with care
 2. Plan in advance
 3. Train labour
3. After reading the key facts, display images of the different materials and equipment used for packing and transporting produce. Trainees should identify the items using **3.4 Key Facts** for reference.



Guided Practice Activity

1. Separate trainees into small groups and tell them to consider the following scenario and write answers to the questions under **Topic 3.3 Task 3** in their manuals. Inform them that they should be prepared to present their decisions to the rest of the class. They can refer to **3.4 Key Facts** as needed.

Imagine you are harvesting tomatoes on your farm in Karongi district. The tomatoes are now mature and need to be packaged and transported to the market in Kibuye city, which is 30 km away. There are about 10 kg of tomatoes, a small amount. You want to

make sure the tomatoes are in the best condition possible so that they sell for a high price.

- a. Which packing method will you use? Explain why.

Answer: Field packing is the best method in this scenario because tomatoes are perishable, and this is a small amount of them.

- b. What steps will you take to arrange the packing? Be specific.

Answer: Handle the tomatoes with care. Plan in advance by contacting buyers, arranging labour, equipment, and transportation, and providing supervision. Train the labourers, either generally or specifically depending on what is needed.

- c. What materials, tools, and equipment will you need for packing and transporting the tomatoes? Explain your selection.

Answers may vary, but wooden crates are the best option for materials. Hammer and nails will be needed to fix the crates. A bicycle is possible, but a truck is preferred.

- d. Which method for transportation will you use? Explain why.

Answers may vary, and either is accepted as long as it can be defended. Bicycle is manual and truck is mechanical.

2. After trainees respond to the questions above and prepare to present their decisions to the rest of the class. Each person in the group should have an opportunity to speak. Encourage trainees to ask and answer questions at the end of each presentation.
3. Explain the correct **Answers** given above.
4. Tell trainees to identify any information they still need to know about packing and transporting food crops. They should write down their questions so that they can ask them in **Task 4**.



Application Activity

Organise a visit to a local food crop farm at harvesting time. Confirm that the farmer will be available to answer questions, give a tour, and demonstrate how to pack the produce.

1. First, instruct trainees to interview the farmer using the questions found in **Topic 3.3 Task 3** in their manuals as well as the ones they created about packing and transporting food crops in **Task 3**. Write the answers in the chart (sample below):

Questions	Answers
Which packing method do you use? Why?	
What are the challenges of packing and transporting food crops?	
Which transportation method do you use? Why?	
Your Question:	
Your Question:	
Your Question:	

2. Take a tour of the farm. Tell trainees to note the materials, tools, and equipment used for packing and transporting in the chart (sample below):

Materials	Tools	Equipment

3. If possible, have trainees observe the farmer pack produce and assist as needed.



Points to Remember

- Wear personal protective equipment, such as gloves, when packing and transporting food crops to avoid hazards.
- When transporting perishable food crops, drive at low speeds and try to avoid rough roads.



Formative Assessment

Write answers to the following questions.

1. What are the advantages of wooden crates?

Answer: Can be made locally, protected against weather, good ventilation

2. What are the advantages of pallet boxes?

Answer: Less manual handling and thus reduced costs, more efficient than smaller crates, faster

3. What is the difference between field packing and using a packing shed?

Answer: Field packing occurs in the field itself and involves less handling of produce. It also involves lower costs and fewer quality losses. Packing sheds, on the other hand, occur in an enclosed building where the produce is protected from weather. Special operations are performed on the produce in packing sheds.

Select True or False for the following statements. **Answers are in bold.**

- ☐ **True:** The goal for packing is to sell to buyers or at the market as soon as possible after harvesting.
- ☐ **False, sacks cannot hold a lot of weight and volume compared to other packing materials:** Sacks are cheap, but they can hold a lot of weight and volume.
- ☐ **True:** Wheelbarrows and bicycles are examples of manual transportation methods.
- ☐ **False, field packing is best for perishable and small amounts:** Packing sheds are best used for perishable and/or small amounts of produce.



Self-Reflection

1. Ask learners to re-take the self-assessment at the beginning of the unit. They should then fill in the table in the Trainee's Manual to identify their areas of strength, areas for improvement and actions to take to improve.
2. Discuss trainees' results with them. Identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Further Information for the Trainer

1. Chakraverty, A.; Mujumdar, A.S.; Raghavan, G. S. V. and Ramaswamy, H. S. (2003). *Handbook of Postharvest Technology*. Marcel Decker, New York, 884 pages
2. Harvest Agricultural Crops:
https://www.agriseta.co.za/downloads/LearningMaterial/116111_LG.pdf
3. Crop harvesting:
https://www.agriseta.co.za/downloads/LearningMaterial/116268_LG.pdf
4. Preparation for the fresh market:
<http://www.fao.org/3/y4893e/y4893e05.htm>
5. Harvesting and field handling:
<http://www.fao.org/3/T0073E/T0073E03.htm>

Summative Assessment

Mr. Kabarira Emmanuel is a professional farmer in Musanze District. He owns three hectares of land where he grows climbing beans (mwirasi variety).

Fatima Hotel has a market demand of 4.5 tons of climbing beans that contain iron mineral. In 2019, he signed a contract with the hotel to supply their beans. However, at the end of the season, Mr. Kabarira has not produced the amount of beans written in the contract—he only produced 2.7 tons. The bean yield has decreased due to inadequate planting operations, maintenance practices, and manure application.

As a skilled farmer, you are requested to demonstrate how the following activities should be performed: food crop planting, food crop maintenance, and harvesting activities.

The space is 40 cm x 20 cm and fertiliser is NPK 5 10 10, applied at a rate of 1kg/m².

These activities must be performed within three hours and on a plot of 4 m².

Resources:

Tools and equipment: Spades, measuring tape, bucket, water container, hoe, shovel, manure fork, furrow opener, machete, saws, sprayer, watering can, wheelbarrow, stakes, notebook, ropes, pen, marker pen, weighing balance, PPE (helmet/head covering, gloves, safety goggles, dust mask, boots).

Materials: Seeds, stakes, fertilisers, bags, baskets.

Assessment Criterion 1: Quality of Process

Checklist	Score	
	Yes	No
Indicator 1: Types of tools, material and equipment are adequately selected		
○ Planting tools		
○ Planting materials		
○ Planting equipment		
Indicator 2: Planting materials are adequately treated		
○ Seeds		
Indicator 3: Planting is well performed		
○ Dibbling method		
○ Spacing method		
○ Sowing method		
Indicator 4: Crop gap filling is well performed		
○ Numbering crop gaps		
○ Filling rate		
Indicator 5: Post planting immediate care is well performed		
○ Watering		
○ Capping		
○ Weed control		
Indicator 6: Farming wastes are properly managed		
○ Collection of farm waste		
○ Disposal of farm waste		
Indicator 7: Completion of records is well done		
○ Data records		
Indicator 8: Crop weeding is well performed		
○ Types of weeds		
○ Weed control methods		
Indicator 9: Crop staking is well performed		
○ Staking materials		
○ Staking methods		
○ Staking techniques		
Indicator 10: Crop fencing is appropriately installed		
○ Fencing materials and equipment		
○ Types of crop fencing		
Indicator 11: Crop irrigation system is well done		
○ Methods of irrigation		
Indicator 12: Pests symptoms and damages are carefully observed and identified		
○ Leave symptoms		
○ Stem symptoms		
○ Roots symptoms		
Indicator 13: Damages are carefully identified		

○ Biting and chewing mouth damages		
○ Piercing and sucking damages		
Indicator 14: Disease symptoms are carefully identified		
○ Leaf symptoms		
○ Stem symptoms		
○ Root symptoms		
Indicator 15: Pesticides are carefully applied		
○ Pesticide application methods		
○ Pesticide dosage		
Indicator 16: Calculation of fertiliser amount at a given rate is well performed		
○ Field area		
○ Recommended fertiliser		
Indicator 17: Application of fertilisers is well performed		
○ Deep soil application		
○ Broadcasting		
○ Band placement		
Indicator 18: Harvesting materials, tools, and equipment are well selected		
○ Hand tools and equipment		
Indicator 19: Materials, tools, and equipment are properly prepared		
○ Cleaning		
○ Adjustment		
Indicator 20: Harvesting methods are well identified		
○ Hand picking method		
Indicator 21: Harvesting operations are properly performed		
○ Reaping		
○ Field threshing		
○ Cleaning		
○ Hauling		
○ Drying		
Indicator 22: Packing area is properly selected		
○ Field packing		
Indicator 23: Packing methods are suitably performed		
○ Field packing		
Indicator 24: Transportation materials, tools, and equipment are properly identified		
○ Wood and plastic materials		
Indicator 25: Produce transport methods are well applied		
○ Manual method		
○ Mechanical method		
Observation		

Assessment Criterion 2: Quality of product

Checklist	Score	
	Yes	No
Indicator 1: Field plot is properly planted		
○ Healthy planting seeds		
○ Prepared field		
○ Vigorous and healthy bean plants		
Indicator 2: Field plot is well maintained		
○ No weeds		
○ No pests and disease symptoms		
○ Climbing beans are properly staked		
Indicator 3: Mature climbing beans are harvested		
○ Matured harvested pods		
○ Dried harvested pods		
○ Dried harvested seeds		
Observation		

Assessment Criterion 3: Relevance

Checklist	Score	
	Yes	No
Indicator 1: Time is effectively managed		
○ Duration is 3 hours or less		
Indicator 2: Plot dimensions are accurate		
○ Plot area is 4 m ²		
○ Length is 2m		
○ Width is 2 m		
Indicator 3: Spacing is accurate		
○ Between rows is 40 cm		
○ Within rows is 20 cm		
Indicator 4: Bean variety is correctly chosen		
○ Mwirasi variety		
○ Yield is 4.5T/ha		
Indicator 5: Fertiliser application doses are correct		
○ Manure/compost ratio is 10 tons/ha		
○ DAP ratio is 100kg/ha		
Observation		

REFERENCES

- AfricaFertilizer.org. (2018). Fertilizer Statistics Overview: Rwanda 2013 – 2017.
<https://africafertiliser.org/blog-post/fertiliser-statistics-overview-rwanda-2013-2017/>
- Cornell University. (2019). Growing Media, Potting, and Labeling.
<https://courses.cit.cornell.edu/hort494/greenhouse/soil/medialft.html>
- CropsReview.Com. (n.d.). Methods of Planting Crops: I. What is Direct Seeding and What is Transplanting? <https://www.cropsreview.com/methods-of-planting.html>
- Farm Management. (n.d.). Calibrating Your Machines Accurately for Harvest.
<https://www.farmmanagement.pro/calibrating-your-machines-accurately-for-harvest/>
- Food and Agriculture Organization of the United Nations. (2013). Good Agricultural Practices for Greenhouse Vegetable Crops. <http://www.fao.org/3/a-i3284e.pdf>
- Food and Agriculture Organization of the United Nations. (1989). Prevention of Post-Harvest Food Losses: Fruits, Vegetables and Root Crops, A Training Manual.
<http://www.fao.org/3/T0073E/T0073E03.htm>
- Hoyt, R. (2018). Four Methods for Applying Fertilizers.
<http://ipm.ucanr.edu/TOOLS/TURF/SITEPREP/amenfert.html>
- Interactive Insights Inc. (n.d.). Vegetable Seeding Techniques: Broadcasting, Hills, Drills.
<http://www.interactiveinsightsinc.com/vegetable-seeding-techniques-broadcasting-hills-drills/>
- Landschoot, P. (2016). Calculations Used to Determine the Amount of Fertilizer Needed to Treat Turf. <https://extension.psu.edu/calculations-used-to-determine-the-amount-of-fertilizer-needed-to-treat-turf>
- Leghari, S. J. (2018, July 20). *Uited*. Wikimedia Commons. <https://commons.wikimedia.org/wiki/File:Uited.png>
License: <https://creativecommons.org/licenses/by-sa/4.0/legalcode>

Lopez Camelo, A. (2004). Manual for the Preparation and Sale of Fruits and Vegetables. Food and Agriculture Organization of the United Nations.

<http://www.fao.org/3/y4893e/y4893e05.htm>

North Carolina State Extension. (2018). North Carolina Extension Gardener Handbook.

<https://content.ces.ncsu.edu/extension-gardener-handbook/5-diseases-and-disorders>

Organic Growers School. (n.d.). Seeds vs. Transplants.

<https://organicgrowersschool.org/gardeners/library/seeds-vs-transplants/>

Proctor, D.L. ed. (2004). Grain Storage Techniques: Evolution and Trends in Developing Countries.

<http://www.fao.org/3/t1838e/T1838E0p.htm> and

<http://www.fao.org/3/t1838e/T1838E11.GIF>

Reynolds, C. and Flint, M.L., University of California Agricultural and Natural Resources, Statewide Integrated Pest Management Program. (2017). Fertilizers vs. Soil Amendments.

<http://ipm.ucanr.edu/TOOLS/TURF/SITEPREP/amenfert.html>

Rice Knowledge Bank. (n.d.). Harvesting. <http://www.knowledgebank.irri.org/step-by-step-production/postharvest/harvesting>

Riyo. (2019). The Definition, Objectives, Advantages of Thinning and Gap Filling.

<https://www.1001artificialplants.com/2019/04/07/define-objectives-advantages-of-thinning-and-gap-filling/>

Rose, A. (n.d.). The Stages of the Flower Life Cycle. <https://www.avasflowers.net/the-stages-of-the-flower-life-cycle>

Simak, E. (n.d.). *Canker on sycamore* [Photograph].

Geograph. <https://www.geograph.org.uk/photo/6333990>

License: <https://creativecommons.org/licenses/by-sa/2.0/legalcode>

Thompson, H. (2019). How to Calculate Fertilizer Rates. <https://blog.supersod.com/calculate-fertilizer-rates>

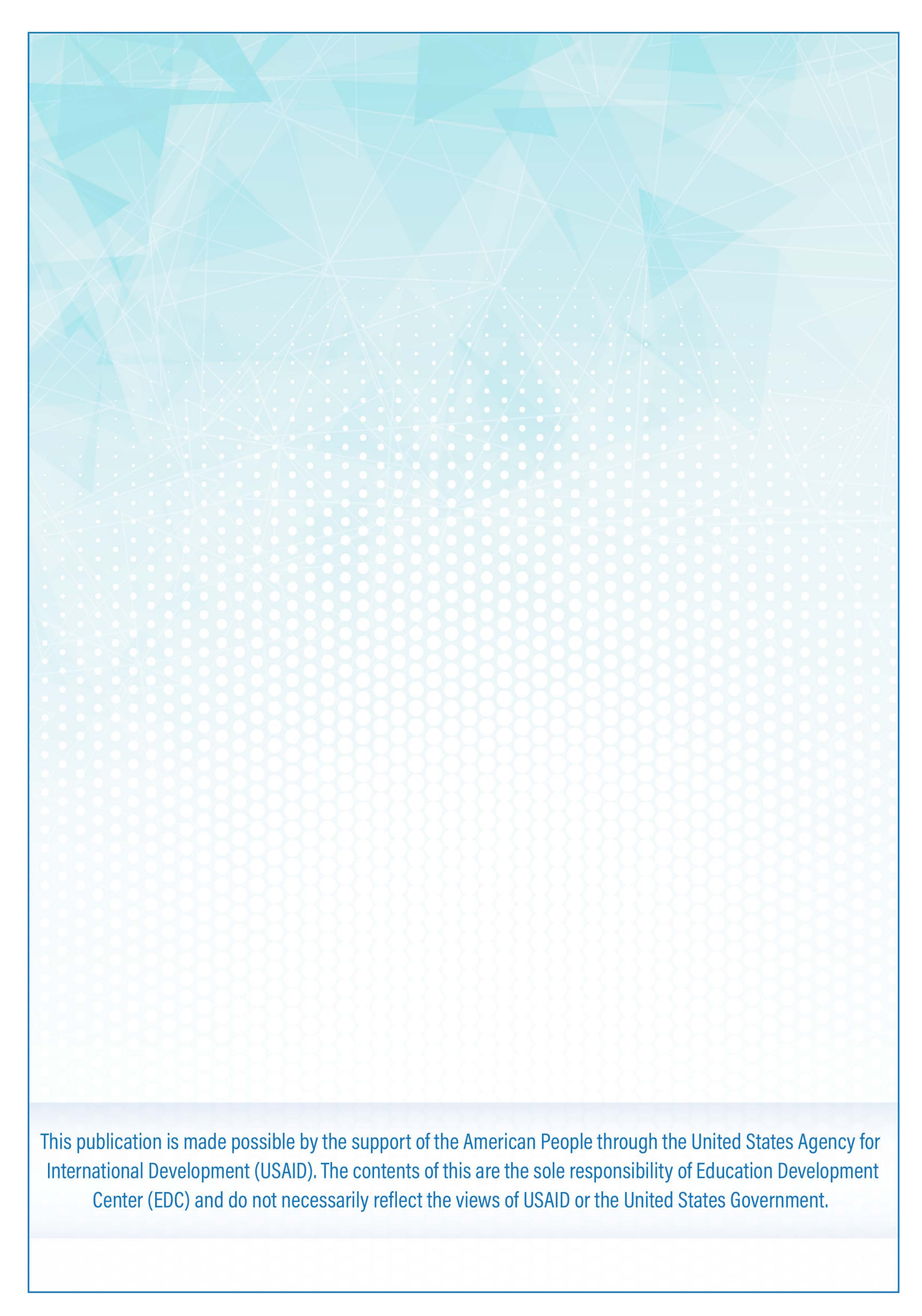
University of Florida, Gardening Solutions. (2018). Plant Diseases.

<http://gardeningsolutions.ifas.ufl.edu/care/pests-and-diseases/diseases/>

User:MAKY_OREL. (2019, February 11). *Germination monocotyledon sprout* [Illustration].

Pixabay. <https://pixabay.com/illustrations/germination-monocotyledon-sprout-3989958/>

License: <https://pixabay.com/service/license/>



This publication is made possible by the support of the American People through the United States Agency for International Development (USAID). The contents of this are the sole responsibility of Education Development Center (EDC) and do not necessarily reflect the views of USAID or the United States Government.

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