RWANDA POLYTECHNIC

TVET LEVEL II

AGRICULTURE

Food Crop Production

TRAINEE MANUAL

RWANDA POLYTECHNIC

Approved by: Workforce Development Authority

USAID FROM THE AMERICAN PEOPLE

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FOOD CROP PRODUCTION

Unit 1: Perform food crop planting activities

Unit 2: Assist with food crops maintenance

Unit 3: Assist with harvesting activities of food crops

Unit 1: Perform food crop planting activities

Topics

1.1 Preparation of planting operations

1.2 Carrying out sowing/planting operations

Unit Summary:

This unit describes the knowledge, attitudes, and skills required to perform food crop planting activities. Upon completion of this unit, the learners will be able to prepare planting operations and carry out sowing/planting operations with close supervision.

Self-Assessment: Unit 1

1. Look at the illustration. What do you see? What do you think this unit will be about? What topics might be covered?

2. Fill in the self-assessment below.

There are no right or wrong ways to answer this assessment. It is for your own use during this course. Think about yourself: do you think you can do this? How well? Read the statements across the top. Put a check in column that best represents your situation. At the end of this unit, we'll take this assessment again.

My experience **Knowledge, skills, and attitudes**	**I don't have any experience doing this.**	**I know a little about this.**	**I have some experience doing this.**	**I have a lot of experience with this.**	**I am confident in my ability to do this.**
Identify the criteria for quality planting materials					
Sort and select planting materials for planting food crops					
Describe and apply pre-treatments of food crop planting materials					
Select the method of planting suitable to the food crop					
Select planting materials according to crops and conditions					
Identify the post-planting immediate care processes					
Describe and perform procedures for safe disposal and recycling of waste after planting					

Topic 1.1: Prepare planting operations

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

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

Topic 1.1 Task 1:

1. Think about the farms that grow crops in or near your community. Discuss the following questions and write down your 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?

2. Observe the photos of planting materials, tools, and equipment provided by the trainer. For each item you are familiar with, identify its use. For each item you are not familiar with, note its name.

Problem Solving Activity

Topic 1.1 Task 2:

1. Individually consider the following scenarios and predict which planting method would be best.

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 equidistantly 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 separate the mounds by the exact same distance, then cover with soil.

2. Compare your answers with a partner, and then the rest of the class.

3. Seeds are not always ready to be planted as soon as you receive them. With your partner, consider what you 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. Share and compare your ideas with the class.

5. Read through **1.1 Key Facts** together. As you read, do the following:
   a. Circle any tools, materials, and equipment you are not familiar with. Ask the trainer for clarification on the items.

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

1.1 Key Facts

- **Types of tools, materials, and equipment:**
  - **Spades and shovels:** used for digging holes and trenches, for transplanting, for scooping compost, manure, and fertiliser
  - **Forks:** used for turning or moving hay and compost, for loosening soil and break-up clods.
  - **Rakes:** used to level off freshly turned soil before planting or sowing the crop
  - **Trowel:** used for digging holes in the soil for planting
  - **Hoes:** used to cultivate between cropping rows and cut through weeds while tilling the soil.
  - **Wheelbarrow:** used to carry tools, fertiliser, seed, and seedlings from on area to the next.
  - **Pegs and cables:** used to design planting rows and show the exact location of planting holes

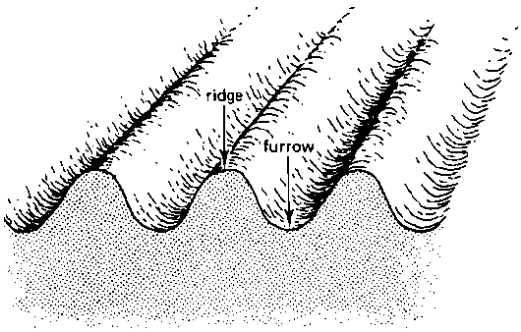
- **Factors for Identification and Selection of Tools and Equipment**
  - Sturdy and Durable: Will last a long time
  - Clean: Free from bacteria and dirt
  - Size: Manageable for the desired soil formations and the person using it
  - Cost: Affordable for the given quality

- **Factors for Identification and Selection of Seed Materials**
  - Adaptivity: Able to adjust to local environment and season
  - Yield: Expected mount of output this type of crop will produce
  - Uniformity: Same variety of crop
  - Cleanliness: Free from pests and diseases and absence of foreign matters
  - Germination: Able to germinate and germination rate (above 90%)
  - Vigour: Sum of the properties which determine the potential level of activity and performance of the seed

- **Pre-Treatments**
  1. **Cleaning:** Remove dirty, foreign materials, damaged seeds

2. **Dormancy Breaking**: Place planting materials under conditions that will favour their germination. Put seeds in darkness and cover with grass until they sprout.
    - In Rwanda, potato seeds need dormancy breaking
3. **Pesticides Treatment**: Prevent negative effects of microorganisms to planting materials (rotting, less vigour, death) by dipping planting materials in a solution containing pesticides; the organisms causing some seed-borne diseases are on the surface of the seed
4. **Seed Coat Breaking:** Use mechanical means, such as rubbing, to sand seeds and break the seed coat; needed for over-dried seeds so they can take in water
5. **Rehydration:** Soak seeds in water to soften the seed coat and increase germination speed

- **Planting Methods** [1] [2] [3]



- **Broadcast Method**
    - Random scattering of seeds on the field or prepared seed bed
    - No specific or definite row spacing of crops
    - Do not need to cover with soil
    - Also called “scatter planting”
    - Commonly used for small plants, such as lettuce and carrots

- **Hill Method**
    - Rows are arranged uniformly and equal distances apart
    - Form mounds or small areas to plant several seeds
    - Dig holes using trowel and place seeds in holes around the mounds/hills/planting area in a circle
    - Cover firmly with soil
    - Commonly used for maize, beans, cucumbers, and pumpkins

[1] 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
[2] Interactive Insights Inc. (n.d.). *Vegetable Seeding Techniques: Broadcasting, Hills, Drills*. http://www.interactiveinsightsinc.com/vegetable-seeding-techniques-broadcasting-hills-drills/
[3] Organic Growers School. (n.d.). *Seeds vs. Transplants*. https://organicgrowersschool.org/gardeners/library/seeds-vs-transplants/

- **Dibbling**: type of hill planting; place seeds in holes made in seedbed and cover them

- **Drill Method**
  - In farming, “drill” means a straight row of plants
  - Seeds are released in a straight line into shallow furrows while walking
  - Cover with soil immediately using rake or foot, then press slightly
  - Spacing between plants may not be regular
  - Commonly used for rice, sorghum, and grain legumes

- **Transplanting vs. Direct Seeding**
  - **Transplanting:** planting or moving pre-grown seedling or plants from pots into growing area
    - Also known as indirect planting or replanting
    - Lower risk due to more control of conditions
    - More resistant to pests and insects
    - May introduce weeds and diseases
  - **Direct Seeding:** planting seeds directly into growing area
    - Used for: plants with delicate roots, plants that are quick to germinate
    - Higher risk of sprouts being harmed by weather conditions
    - Can be less expensive in large quantities
  - **Consider:** The crop species to be grown, ease in planting and survival rate, farmer's familiarity, timeliness, financial capability of the farmer, return on investment

Guided Practice Activity

Topic 1.1 Task 3:

1. Read the scenario in small groups:

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. Complete the following tasks with your group. Refer to **1.1 Key Facts** for guidance as needed.

a. Describe the factors they should consider when selecting seeds.

b. Identify the pre-treatments they should perform if their seeds are covered with dirt and have been exposed to harmful bacteria.

c. Explain the planting method they should use for their seeds.

d. List the tools and equipment they will need to perform this planting method.

e. Recommend either transplanting or direct seeding and explain why.

2. Take turns presenting each group's advice to Damascene to the class. Discuss any differences in advice and verify the correct answers with the trainer.

3. Next, match the planting tools and equipment to their uses by drawing a line. **Fork** has been done as an example. Do not use **1.1 Key Facts** at this time.

Tool or Equipment	Use
Fork	Carry tools, fertiliser, seed, and seedlings from one area to the next.
Spade or shovel	Level off freshly turned soil before planting or sowing the crop
Wheelbarrow	Design planting rows and show the exact location of planting holes
Trowel	Cultivate between cropping rows and cut through weeds while tilling the soil.
Pegs and cables	Dig holes and trenches, transplant, scoop compost, manure and fertiliser
Hoe	Turn or move hay and compost, loosen soil and break-up clods
Rake	Dig holes in the soil for planting

4. Verify your answers by reading **1.1 Key Facts**. Correct any errors.

Application Activity

Topic 1.1 Task 4:

Visit a local crop farm with your class.

1. Take a tour of the crop area/field and do the following:
   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. Confirm your observations with the farmer or another worker.

3. Interview the farmer using the following questions, plus one of your own. Be sure to write down the farmer's responses in the 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. Offer to assist the farmer with any seed pre-treatments needed. Wear personal protective equipment (PPE) when handling chemicals.

5. After the visit, discuss with your class:

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 the chemicals or materials.

Formative Assessment

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:

a.

b.

5. Name two factors that should be considered when identifying and selecting seeds:

a.

b.

Topic 1.2: Carrying out 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

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

Topic 1.2 Task 1:

1. With a partner, discuss the statement: "A plant is only as good as its roots."
   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. Share and compare your answers with the rest of the class.

Problem Solving Activity

Topic 1.2 Task 2:

1. Consider the following scenario:

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. Discuss the questions with a partner. Be creative!

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

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

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

3. Share your ideas with the rest of the class.

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

a. Waste disposal

b. Record keeping

5. With your partner, 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?

b. What are the three methods for waste management?

1.

2.

3.

c. Why is record keeping useful?

6. Verify your responses with the trainer.

1.2 Key Facts

- **Growing Media and Materials**
  - **Soil Medium**
    - Chemical: pH levels and cation exchange capacity/CEC (capacity to store nutrients)
    - Physical: Consider bulk density (weight of soil in a given volume) and air porosity (volume of air space occupied by air after saturation and draining)
  - **Greenhouse Setting**
    - Growth depends on combination of water retention, air porosity, and growing medium

    - Goal: Grow plants that require heat in colder seasons by keeping them in greenhouses with stable temperatures all year
    - Problems occur during warm seasons when temperatures are too high
        - Must use ventilation and cooling in greenhouse
- **Pot and Box Containers** [4] [5]
    - Plants may stay in the same pot forever or be transplanted to larger containers
    - Various types, shapes, and materials based on the plants' needs
        - Most common are round
    - Helpful for transporting plants efficiently
    - Deeper containers provide better drainage
    - Fill all the way with soil; surface should be uniform

- **Crop Gap Filling** [6]
    - The process of transplanting plants from an over-crowded area to an open one to optimize plant population in the field
    - Gaps are caused by birds or animals eating seeds and seedlings that failed to grow after being transplanted
    - Be aware of planting density because over-crowding will reduce productivity and product quality

- **Post-Planting Immediate Care**
    - **Compact**: Press soil down slightly around the plant
    - **Water**: Irrigate well after planting to provide moisture needed for germination
    - **Mulch**: to prevent water loss, protect the seeds from being eaten by birds, and increase the temperature around the seed to speed up the germination
    - **Thin and Fill**: Remove feeds and fill gaps where previous seeds did not germinate with plants from over-crowded areas

- **Waste Management**
    - **Recycling**: Unused plant parts can be composted
    - **Re-use**: Bags and other materials used during planting operations but were not in contact with harmful chemicals can be collected and be re-used in other operations

[4] Cornell University. (2019). Growing Media, Potting, and Labeling. https://courses.cit.cornell.edu/hort494/greenhouse/soil/medialft.html

[5] Food and Agriculture Organization of the United Nations. (2013). *Good Agricultural Practices for Greenhouse Vegetable Crops*. http://www.fao.org/3/a-i3284e.pdf

[6] 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/

- **Safe disposal**: Containers of seeds and other products used during planting operations and were in contact with harmful chemicals must be disposed in prepared area where they won't cause harm to the environment

- **Records**
  - **Importance**: Helps the farmer plan and forecast for the future; indicates which planting methods and materials work
  - **Data**:
    - Site location
    - Variety/Cultivar (variety produced by selective breeding)
    - Date of planting
    - Spacing used (planting densities)
    - Planted area
    - Fertilisers used

Guided Practice Activity

Topic 1.2 Task 3:

Visit the school farm with your class.

1. Collaborate with a small group to do the following tasks:

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, share your experience and findings with the rest of the class.

Application Activity

Topic 1.2 Task 4:

1. Visit a local crop farm with your class. Begin by doing the following:

a. Tour the crop field.

b. Identify the food crops grown and the media used by taking notes in the chart below:

Food Crops	Media Used

2. If applicable, observe and assist the farmer as he or she demonstrates how to plant and give post-planting care to the seed.

3. Ask the farmer if he or she uses thinning and gap filling. Identify where this practice has been used and assist, if possible.

4. Ask the farmer any questions you have about planting operations.

5. After the field visit, discuss with your class:
   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

Complete the following sentences:

1. While plant containers come in various shapes, sizes, and materials, the most common shape is ……

2. Mulching prevents …… loss, protects the seeds from being eaten by birds, and increases the ……. around the seed to speed up germination.

3. Soil media must be assessed for their physical and …… properties, such as bulk density and …….. levels.

Write answers to the following:

4. Name three pieces of data that should be collected during planting record keeping:

a.

b.

c.

5. What is gap filling and why is it used?

6. How should waste be disposed of safely?

Self-Reflection

1. You have come to the end of the unit. You are going to do the survey you did at the beginning of the unit again to help you do self-assessment of your knowledge, skills and attitudes.

Again, there are no right or wrong answers to this survey. It is for your own use to gauge your knowledge, skills and attitudes after the unit. Read the Knowledge, Skill or Attitude in the left column. Think about yourself: do you think you can do this? How well? Read the statements across the top. Put a check in column that best represents your situation.

My experience **Knowledge, skills, and attitudes**	**I don't have any experience doing this.**	**I know a little about this.**	**I have some experience doing this.**	**I have a lot of experience with this.**	**I am confident in my ability to do this.**
Identify the criteria for quality planting materials					
Sort and select planting materials for planting food crops					
Describe and apply pre-treatments of food crop planting materials					
Select the method of planting suitable to the food crop					

My experience Knowledge, skills, and attitudes	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Select planting materials according to crops and conditions					
Identify the post-planting immediate care processes					
Describe and perform procedures for safe disposal and recycling of waste after planting					

2. Complete the table below by identifying areas from the unit where you have improved and where you need improvement with the actions/strategies you will use to help you improve when receiving and interpreting information at the workplace

Areas of strength	Areas for improvement	Actions to take to improve
1. **2.**	**1.** **2.**	**1.** **2.**

Unit 2: Assist with food crops maintenance

Topics

2.1 Performance of crop maintenance practices

2.2 Assistance with managing pests and diseases

2.3 Using fertilisers on food crops

Unit Summary:

This unit describes the knowledge, attitudes, and skills required for food crop maintenance activities. Upon completion of this unit, you will be able to perform food crop maintenance practices, assist with managing pests and diseases, and use fertilisers on food crops with close supervision.

Self-Assessment: Unit 2

1. Look at the unit illustration. What do you see? What do you think this unit will be about? What topics might be covered?

2. Fill in the self-assessment below.

There are no right or wrong ways to answer this survey. It is for your own use during this unit. Think about yourself: do you think you can do this? How well? Read the statements across the top. Put a check in column that best represents your situation. t the end of this unit, we'll take this survey again.

My experience **Knowledge, skills, and attitudes**	**I don't have any experience doing this.**	**I know a little about this.**	**I have some experience doing this.**	**I have a lot of experience with this.**	**I am confident in my ability to do this.**
Describe and select the purposes of various crop maintenance practices					
Explain and compare the different types of crop maintenance practices					
Describe the methods and techniques for performing crop maintenance practices					
Practice crop maintenance practices					
Describe pests and diseases symptoms					
Identify damages based on pest and disease symptoms					
Explain and differentiate between the different types of damages due to pests					
Describe pesticide preparation and safety procedures					
Apply pesticides to control pests and diseases in food					

My experience Knowledge, skills, and attitudes	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
crops by following instructions					
Describe the different types of fertilisers					
Choose fertilisers following recommendations					
Describe techniques for applying fertilisers					
Apply fertilisers using recommended techniques					
Explain the steps needed to calculate the amount of fertiliser needed for a given field area					
Calculate the amount of fertiliser needed for a given field area					

Topic 2.1: Performance of crop maintenance practices

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

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

Topic 2.1 Task 1:

1. 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. Discuss your ideas with a partner.

3. Then, discuss with your partner:

a. What is the purpose of crop maintenance?

b. Why is it important?

4. Share your ideas with the rest of the class.

Problem Solving Activity

Topic 2.1 Task 2:

1. Match the crop maintenance practice to its definition by drawing a line between the practice and the definition.

Crop Maintenance Practice	Definition
Staking	To remove unwanted plants from a planting area
Mulching	To pile soil up around the base of a plant
Thinning	To insert a stake beside a plant in order to provide it with support while it grows
Weeding	To place a layer of non-living material over the soil surface to smother weeds
Ridging/Hilling/Earthing Up	To remove excess seedlings

2. Confirm your answers with the trainer.

3. With a partner, predict which tools you will need for each practice by writing them into the chart provided under "Tools Needed."

Crop Maintenance Practice	Tools Needed	Types or Methods
Staking		
Mulching		
Thinning		
Weeding		
Ridging/Hilling/ Earthing Up		

4. With your partner, 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.

2.1 Key Facts

Mulching

- **Definition**: To place a layer of non-living material (mulch) over the surface of the soil to smother the weeds and cut them off from direct sunlight
- **Types/Methods**:
  - **Organic**: Made of cut grass or vegetable waste; prevents surface sealing by avoiding direct raindrops impact on the soil
  - **Live**: Food crop is planted directly in the living cover of an established cover crop without destruction of the cover crop vegetation
  - **Plastic**: Suppresses weeds and conserves moisture from the soil as well as erosion reduction; restricts water infiltration; placed prior to planting and perforated to leave a hole where the plant will emerge
- **Materials:** Cut grass or vegetable waste; rolls of plastic bags
- **Techniques:**
  - Apply mulch after young plants have become somewhat strong and sturdy

- Mulch layer should not be too thick in order to allow seedlings to grow through it
- Can be applied over established crops, between the rows, directly around single plants, or evenly spread on the field

- **Parameters**
  - Mulch should be applied before or at the onset of the rainy season
  - When the soil is most vulnerable and needs protection

Weeding

- **Definition:** To remove unwanted plants (weeds) from a planting area
- **Types of Weeds**
  - **Annual**: Complete their life cycle, from seed germination to seed production, in one year
  - **Biennial**: Require two seasons to complete their growth
  - **Perennial**: Live for more than two years
- **Weed Control**
  - **Cultural Method**: All aspects of good crop cultivation used to minimize weed interference with crop, including tillage, burning, flooding, and crop rotation
  - **Mechanical Control**: Weeding by hand (pulling, slashing hoeing) or using a machine (weedwhacker)
  - **Chemical Control**: Use herbicide chemicals to kill weeds or prevent their growth
  - **Natural Control:** Use organic material such as vinegar; practice crop rotation—growing different crops after one another on the same land—to prevent weeds from adapting to a specific crop

Thinning

- **Definition**: To remove excess growing seedlings
- **Methods**:
  - **Hand**: Uproot using hands, hoes, and machetes
  - **Cluster/Bumping**: Remove clusters of fruit or "bump" fruit from trees to make space for further growth
  - **Chemical**: Spray with chemicals to cause fruits to increase in size and drop
- **Advantages:**
  - Opportunity to select out weak seedlings
  - Retains vigorous seedling
  - Ensures that every area has the correct number of seedlings

Ridging/Earthing Up/Hilling

- **Definition**: To pile soil up around the base of a plant and bury the above-ground part of the plant

- **Methods**:
  - **Hand**: Using a hoe, or with powered machinery, typically a tractor attachment
  - **Hoeing**: Break up surface of the ground and move it into mound shape around plant base
- **Advantages:**
  - Stabilizes the stems of crops and protect them from wind
  - Promotes growth
  - Supports the base of the plant and allows for the formation of a better root system
  - Provides proper water drainage

Staking

- **Definition**: To insert a stake beside a plant in order to provide it with support while it grows
- **Materials:** Bamboo canes, spare sticks and branches from trees, string, wire
- **Methods:**
  - **Single Pole:** Push one stake into the ground beside the plant and tie the plant to the stake using sting
  - **Tripod/Pyramid:** Poles are staked in groups of three and bound at the top using string or wire in the shape of a pyramid
  - **Crossed Poles:** Create grids using sticks or bamboo canes for vines to grow between
  - **Live Staking:** Use trees as stakes
- **Techniques:**
  - **Angled Stake:** Used on slopes/hills; plant at a 45 degree angle
  - **Tall, Straight Stake:** Tie plant 2/3rds of way up its stem to the stake; make sure stake is not taller than the plant
  - **Two Stakes:** Tie plant between two sticks or canes
- **Advantages**:
  - Prevents toppling and snapping of plants caused by either the heavy weight of bunches or by the wind

Guided Practice Activity

Topic 2.1 Task 3:

1. Separate into small groups and the trainer will assign your group one of the crop maintenance practices.

2. With your group, use the resources available to you (textbooks, other trainers or teachers, the internet) to do further research on this crop maintenance practice. 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, supplement your 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. With your group, create a presentation of the information from **2.1 Key Facts**, **2.2 Key Facts,** your independent research, and your field visit to a farm. Use the classroom flipchart. Make sure each group member is given the opportunity to speak.

5. Present your group's findings to the class. Answer any questions. Listen to other groups' presentations and ask them questions.

2.2 Key Facts

Fencing [7]

- **Definition**: A barrier used to keep animals in or out of an area
- **Materials and Equipment:** posts, barbed wire, staples, plastic, gates
- **Types:**
  - **Staples:** Used to secure fences and increase their durability
  - **Cable:** Horizontal lines of steel attached to vertical poles

[7] Worley, J. Cooperative Extension Service, The University of Georgia, College of Agricultural and Environmental Sciences. (2000). Fences for the Farm. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_023913.pdf

- **Barbed Wire:** Lines of steel with sharp edges or points at intervals
- **Advantages**: Protects crops from animals and from thieves

Irrigation Systems

- **Purpose**: When there is not enough rainfall, plants must receive additional water from irrigation
- **Methods**
  - **Surface Irrigation**:
    - Water distributed by gravity flow across the surface of the field.
    - Either the entire field is flooded (basin irrigation) or the water is fed into small channels (furrows) or strips of land (borders)
  - **Basin Irrigation:**
    - Create basins by building embankments or barriers around flat areas of land, then flood flat areas with water
    - Commonly used for paddy rice and bananas; any crops that are unaffected by standing in water for long periods (e.g. 12-24 hours)
    - Not recommended for potatoes and cassava
    - Can construct basins on sloping land, even when the slope is quite steep using terraces which are like the steps of a staircase
  - **Furrow/Flood Irrigation:**
    - Furrows are small channels, which carry water down the land slope between the crop rows.
    - Water is distributed into the soil as it moves along the slope.
    - Crops are grown on the ridges between the furrows
    - Requires uniform flat or gentle slopes to assist drainage following irrigation or excessive rainfall with high intensity
    - Commonly used with row crops such as maize, sunflower, sugarcane, soybeans; crops that would be damaged by too much water, such as potatoes, beans; broadcast crops such as wheat.
  - **Sprinkler Irrigation:**
    - Similar to natural rainfall
    - Water is distributed through a system of pipes usually by pumping, then sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground
    - Must be designed to enable a uniform application of water
    - Commonly used for most row, field, and tree crops
    - Requires a clean supply of water, without sediments
  - **Drip Irrigation:**
    - Water is put under pressure through a pipe system to the fields, where it drips slowly onto the soil through emitters or drippers which are located close to the plants

- Only the immediate root zone of each plant is watered
- Very efficient method of irrigation
- Water must be free of sediments
- Best method to use when water is scarce.
- Not recommended for food crops because of high initial costs of installing them

- **Centre Pivot Irritation:**
  - One sprayer connected to a pivot mechanism that rotates in a circle
  - Commonly used for crops such as maize and beans

Application Activity

Topic 2.1 Task 4:

Visit a local crop farm with your class.

1. Tour the farm with the farmer or another worker.

2. Identify the fencing and irrigation systems in place. Ask the farmer why he or she chose this particular system and its challenges. Note the information in the chart below.

	Fencing	**Irrigation**
Type/Method		
Reason		
Challenges		

3. Ask the farmer any other questions regarding crop maintenance practices, similar to those you asked in the previous activity.

4. After the field visits, discuss with your class:
   a. What did you learn?

b. What surprised you?

c. What do you still need information about that is not in **2.2 Key Facts**?

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.

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	Use organic material or crop rotation method
Natural	Use 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?

a.

b.

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

a. Fencing:

b. Thinning:

c. Staking:

Topic 2.2: Assistance with managing pests and diseases

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

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

Topic 2.2 Task 1:

1. With a partner, do the following tasks:

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.

Pests	Diseases

c. Discuss your own experiences with pests and diseases while growing plants or crops.

2. Share your ideas with the rest of the class.

3. As a class, discuss: How do pests and diseases affect plant health?

Problem Solving Activity

Topic 2.2 Task 2:

1. Identify the stem, root, and leaves of this plant by labelling each part.

2. Confirm your answers with the trainer.

3. 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:

	Shapes	Size	Colour	Other Notes
Figure 1				
Figure 2				
Figure 3				
Figure 4				

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

Figure 1:

Figure 2:

Figure 3:

Figure 4:

4. With the rest of the class:

a. Share and compare your ideas for **Question 3**.

b. Discuss: How can we prevent pests and diseases from affecting plant health?

5. Read through **2.3 Key Facts**. As you read, 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**, write answers to the following questions:

a. What are the types of pest mouth parts that cause damages?

b. What are the differences between them?

2.3 Key Facts

- **Plant Pests:**
  - Include insects, mites, slugs, nematodes, centipedes (all invertebrates)
  - Damages depend on the pests' mouth parts and the symptoms they leave behind

- **Pest Damages:**[8]
  - **Biting/Chewing**:
    - Eat into leaves, stems, and roots
    - Clear signs that pests have been present, such as holes
  - **Piercing/Sucking**:
    - Make a small hole in the plant and suck out the fluids
    - Less obvious and more difficult to diagnose because plant looks the same and only the inside fluids are removed
    - Weakens plants and can transmit plant diseases

- **Pest Symptoms**
  - **Leaf**
    - Wilting: Leaves become limp due to loss of water/fluids
    - Leaf Spots: Discoloured (often brown or dark) spots
    - Mosaic: Patchwork of colours (usually light green, yellow, dark green)
    - Yellowing: Leaves turn yellow colour
    - Distortion: Leaves become twists or curled
    - Little Leaves: Leaves do not grow to full size
    - Galls: Abnormal growths due to eggs laid by insects

[8] University of Florida, Gardening Solutions. (2018). Different Pests Cause Different Damage. http://gardeningsolutions.ifas.ufl.edu/care/pests-and-diseases/pests/management/different-pests-different-damage.html

    - Drying/Necrosis/Blight: Death of cells or tissues that causes leaves to darken and wilt

- **Stem**
    - Wilting: Stem becomes limp due to loss of water/fluids
    - Witches' Broom: Abnormally high number of shoots in one area
    - Cankers: Dead areas or open wounds on a plant
    - Yellowing: Turns yellow colour
    - Galls: Swells/growths on stems

- **Root**
    - Wilting: Plant becomes limp/weak
    - Water Moulds: Organisms caused by overwatering or too much moisture
    - Distortion: Do not grow as expected
    - Drying/Necrosis/Blight: Death of cells or tissues in roots that leave holes

- **Fruit**
    - Spots: Rotted areas, discoloured and/or disintegrated

- **Plant Diseases**
    - Caused by viruses, fungi, and bacteria
    - Difficult to identify; often mistaken for environmental or maintenance problems

- **Disease Symptoms** [9] [10]
    - **Plant and Leaf**
        - Stunting: Plant does not grow to its full size
        - Spots: Dark or discoloured areas
        - Galls: Abnormal growths/lumps on leaves
        - Elongation: Abnormally long growth of leaves
        - Water Soaked: Darkened, sunken, and/or translucent area
        - Discolouration/Yellowing: Turns pale yellow colour
        - Ring Spot: Circular lesions of tissue on leaves

    - **Stem**
        - Galls: Abnormal growths/lumps on stem
        - Elongation: Abnormally long stem growth
        - Blight: Rapid death of plant tissue

[9] North Carolina State Extension. (2018). *North Carolina Extension Gardener Handbook*. https://content.ces.ncsu.edu/extension-gardener-handbook/5-diseases-and-disorders
[10] University of Florida, Gardening Solutions. (2018). *Plant Diseases*. http://gardeningsolutions.ifas.ufl.edu/care/pests-and-diseases/diseases/

- Wilting: Stem becomes weak or limp
- Damping Off: Death of seedling before or after emergence from soil

- **Root**
  - Galls: Swellings/growths on root tissue
  - Root Knot: Caused by parasitic nematodes that drain nutrients
  - Cankers: Dead areas
  - Edema (oedema): Bumps, blisters, or crystal-like growth on underside of leaves
  - Wilting: Roots become weak or limp
  - Darkening and Softening
  - Lesions: Holes in root systems
  - Rots: Decay of roots

- **Fruits and Flowers**
  - Rots: Soft, discoloured areas where fruit has been infected
  - Cankers: Usually occur on fruit tree branches or trunks and kill the portion of the tree above that point
  - Wilting: Weak/limp areas where plant droops downward

Guided Practice Activity

Topic 2.2 Task 3:

1. Match the symptom to its definition and its image. **Wilting** has been done as an example.

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	 [11]
Distortion	Swellings or growths	

[11] 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. With your class, go to the school farm and do the following in small groups:

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, work with your small group to do the following:

a. Discuss how pests and diseases could be prevented on the farm.

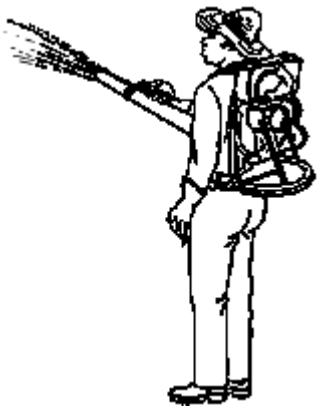
b. Discuss how pests and diseases could be treated on the farm.

c. Read through **2.4 Key Facts**

2.4 Key Facts

- **Pesticides**
  - Chemical substances used to prevent or kill insects or other pests and diseases from harming plants
  - Can be dangerous and should be used with caution (see safety measures below)

- **Tools and Equipment**
  - Hand-operated hydraulic sprayers
    - Such as knapsack sprayers (see image on the right)
    - Commonly used in Rwanda
  - Dusters
    - Gets pesticide into the cracks and crevices
    - Good for small pests
  - Clean pumps and clean water for mixing
  - Considerations:
    - Cost of equipment and application
    - Size of the land
    - Frequency of application



- **Application Methods**

- Spraying: Use sprayers to direct pesticides in broad areas while walking through field
    - Most common in Rwanda
- Drenching: Add pesticides directly into soil
- Dusting: Spray pesticides into specific, small areas
- Fumigation: Release a gas into the air
- Baiting: Leave baits to attract the pests to a certain area and then trap and kill them

- **Dosage**
    - Always read the pesticide label first for the dosage and mixing procedures
    - Mixing:
        - Open with care to avoid spilling
        - Mix in an open place to avoid accumulation of fumes
        - In some cases, it may be required that the compounds are pre-mixed in a separate container
        - In general, the procedure is to fill the spray tank halfway
    - Procedure:
        1. Measure the pesticide
        2. Add pesticide to the tank
        3. Fill the tank to the correct level
        4. Stir thoroughly

- **Safety Procedures**
    - Wear personal protective equipment (PPE)
        - When handling, mixing and applying the pesticides
        - Including: long sleeved shirt, long trousers, goggles or glasses or a face shield to protect the eyes, boots (preferably rubber or impermeable boots), gloves (preferably rubber or impermeable gloves), dust mask (for dry formulations) or respiratory protector, hat
    - Read and follow the manufacturer's label for use. Information includes:
        - PPE required
        - What crops and pests the product can be used for
        - Dosage rate
        - Timing of application
        - The time required before anyone can re-enter the field after spraying (REI)
        - The number of days a product must be sprayed prior to harvest; pre-harvest interval (PHI)
        - Other precautions
    - Disposal:
        - Do not reuse empty containers

- Rinse empty containers with clean water, then flatten and bury them at a disposal site
- Disposal site: At least 50 m from the nearest water source (dam, river and borehole); on relatively high ground or where the ground water is at least 2 m deep; not in sandy soils that leach easily; and fenced in with a signpost

- Importance:
  - Protects both the farmer and the consumers
  - Reduces environmental contamination
  - Maintains the effectiveness of the pesticides

Application Activity

Topic 2.2 Task 4:

Visit a local farm with plants/crops.

1. Before visiting the farm, work in small groups to create interview questions for the farmer. Write the questions in the chart below. The questions should address the following points. You can also create a question on a topic of your 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, take turns interviewing the farmer using the questions you created with your group. Do not ask a question again if it has already been asked by another group. Write the farmer's answers in the chart above.

3. After interviewing the farmer, take a tour of the farm.
   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. Observe and assist farmer with disease and pest treatment methods.

5. After the visit, discuss with your class:
   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.

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.

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

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

Leaf	**Stem**	**Root**
1.	1.	1.
2.	2.	2.

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

Leaf	**Stem**	**Root**
1.	1.	1.
2.	2.	2.

Topic 2.3: Using fertilisers on food crops

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

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

Topic 2.3 Task 1:

1. 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. Share your ideas with the rest of the class.

3. Volunteer to share any experience you or someone in your community has had using fertilisers on their food crops. Listen to others' experiences.

Problem Solving Activity

Topic 2.3 Task 2:

1. In small groups, predict the difference between the following concepts. One person should write down your 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. Select one person from your group to share your group's ideas with the rest of the class. After each group has shared, compare your responses. Discuss the following:
   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. With your group, read **2.5 Key Facts.**

4. With your group, identify the terms from **Question 1** and explain the differences by writing them below using **2.5 Key Facts.**
   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. As a class, discuss:
   a. What are the different types of fertiliser application methods? Which do you think is best and why?

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

2.5 Key Facts

- **Fertilisers**
  - Can be natural or manufactured material
  - Contain at least 5% of one or more of the three primary nutrients for plant growth: nitrogen (N), phosphorus (P), or potassium (K)
  - Directly improve the supply of nutrients in the soil

- **Soil Amendments** [12]
  - Can be natural or manufactured material
  - Improve the soil's physical or chemical conditions, such as water drainage or acidity
  - Indirectly improve plant growth

- **Types**
  - **Organic**: Made from living materials and do not use chemicals; supply plant nutrients in small quantities and organic matter in large quantities
    - **Manure:** Reused animal faeces; green manure uses
    - **Compost:** Well-rotted vegetable matter which is prepared from waste
  - **Mineral**: Industrially manufactured fertilisers that contain one or more of the essential nutrients (nitrogen, phosphorous, and/or potassium)
    - **Single, Simple, or Straight Fertilisers:** Contain only one of the major elements
    - **Mixed or Compound Fertilisers**: Contain two or more of the major elements

- **Application Methods** [13]
  - **Deep Soil Application:** Mix into soil using plough or another tool; worked into the soil before planting
  - **Broadcasting:** Spread over the entire soil surface evenly and uniformly; mainly used with rice
  - **Band Placement:** Place into the soil close to the seed or plant; used for small quantities of fertilisers; promotes rapid early growth
  - **Liquid Application:** Apply through irrigation water; straight or mixed fertilisers dissolve in the irrigation stream; nutrients are thus carried into the soil as a solution

[12] 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

[13] Hoyt, R. (2018). Four Methods for Applying Fertilizers. http://ipm.ucanr.edu/TOOLS/TURF/SITEPREP/amenfert.html

- **Application Timing**

Food Crop	Application Timing
Maize	At planting When the plant has 6-8 leaves
Wheat	At planting Six weeks after planting
Rice	At transplanting 3 weeks after and at booting stage
Beans	At planting
Bananas	At planting Every year fertiliser is side dressed ½ of the fertiliser mixture is applied at planting and the rest 3 months after applied on circle around the plant on radius of 60 cm.
Cassava	Manure is applied during land preparation and NPK applied after sprouting of cassava cuttings by side dressing at the distance of 10cm around the plant
Potato	Applied by hill application at planting time

- **Signs of Soil Nutrient Deficiencies**
  - Stunted growth, chlorosis, interveinal chlorosis, purplish-red colouring, necrosis
  - Many deficiency symptoms show the deficiency of not just one element in the soil, but many. Therefore, it is advised to test the soil in order to know the right recommendation of fertilisers.

Guided Practice Activity

Topic 2.3 Task 3:

1. Separate into small groups. The trainer will assign each group a food crop in Rwanda.

2. With your group, conduct independent research on your assigned food crop. Consider the following resources while conducting your research:
   a. The internet
   b. Books
   c. Your trainer and/or other staff at school
   d. Community members, such as shop keepers and farmers

3. Your research should address *at least* the following points:
   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. Collaborate with your group to create a presentation for the rest of the class. Be sure to verify all the information collected during your research.

5. Present your findings to the rest of the class. Listen to the presentations of other groups. Record the information using the chart below:

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

6. After the presentations, discuss the following questions as a class:

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?

7. Read through **2.6 Key Facts**. Verify your predictions from **Question 6** with the information given.

8. Try this 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 m^2. The area of your field is 10,000 m^2, or 1 hectare (ha). How much fertiliser is needed to cover the entire field?

9. Compare your answer with a partner. Then, verify it with the trainer.

2.6 Key Facts

- **Fertiliser Rates Calculation**
  - **Calculation:** How much fertiliser to use given the amount of nutrient to be applied
  - **Variables**
    - Field Area = Length * Width of field
    - Nutrient Rate = Nutrient desired per given area
    - Amount of Nutrient = Area * Nutrient Rate
    - Amount of Fertiliser = Nutrient Rate / Concentration
  - **Nutrient Analysis**
    - Fertiliser names and/or labels indicate their concentration of nutrients
    - N = Nitrogen, P= Phosphorus, and K = Potassium
    - For example, NPK 17 17 17 is a type of fertiliser that contains 17% nitrogen, 17% phosphorous, and 17% potassium
  - **Steps** [14] [15]
    1. Identify the **nutrient rate** (amount of nutrient desired/to be applied) per hectares (ha)
    2. Identify the **amount of nutrient** desired

[14] Thompson, H. (2019). *How to Calculate Fertilizer Rates*. https://blog.supersod.com/calculate-fertilizer-rates
[15] 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

3. Divide the **amount of nutrient** desired by the percentage/**concentration** of nutrient in the bag (as a decimal)

- **Example**
  - You have the NPK 22 6 12 fertiliser. You want to apply it to the field at a rate of 1 kg of nitrogen per 100 m^2. The area of your field is 10,000 m^2, or 1 hectare (ha). How much fertiliser is needed to cover the entire field?
    1. Nutrient Rate = 1 kg/100 m^2
    2. Amount of Nutrient desired for the given area
       = 1 kg / 100 m^2 * 10,000 m^2
       = 0.01 * 10,000
       = 100 kg of nitrogen for an area of 10,000 m^2
    3. Nutrient desired / Concentration (22% nitrogen = 0.22)
       = 100 kg / 0.22
       = 455 kg of NPK 22 6 12

- **Note:** If you were given the rate of phosphorous or potassium instead of nitrogen, you would use .06 to calculate with phosphorous or .12 to calculate if given the rate of potassium per the given area.

- Rwanda [16]
  - Most Common Products: NPK, DAP, Urea

Crop	Fertiliser Used
Maize, Potatoes	NPK 17 17 17
Coffee	NPK 22 6 12
Soybeans, Wheat	DAP

  - Most fertilisers in Rwanda are imported from Tanzania

Application Activity

Topic 2.3 Task 4:

[16] AfricaFertilizer.org. (2018). *Fertilizer Statistics Overview: Rwanda 2013 – 2017*. https://africafertiliser.org/blog-post/fertiliser-statistics-overview-rwanda-2013-2017/

You will be visiting a local food crop farm with your class.

1. Before visiting the farm, prepare questions to interview the farmer with regarding fertiliser types, application methods, application timing, and rates. In small groups, create 6 questions and write them below:

1.

2.

3.

4.

5.

6.

2. Select one representative from each group to share your questions with the class. As a class, vote on the best 6 questions and write them into the chart below:

Questions	**Answers**

3. Upon arriving to the farm, interview the farmer and write the responses in the chart above.

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, calculate the amount of fertiliser needed for this crop. Verify your answers with the farmer and the trainer.

5. If possible, observe and assist the farmer in applying fertiliser to their farm.

6. After the visit, discuss with the class:

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 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?

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

1.

2.

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 m^2.

Complete the following sentences:

4. Signs of nutrient deficiency include stunted growth, ……., interveinal chlorosis, purplish-red ……., and necrosis.

5. The band placement application method involves placing fertiliser into the soil …….. to the seed or plant and is used for ……. quantities of fertiliser.

6. The primary nutrients for plant growth are nitrogen (N), …….. (P), or potassium (……).

Self-Reflection

1. You have come to the end of the unit. You are going to do the survey you did at the beginning of the unit again to help you do self-assessment of your knowledge, skills and attitudes.

Again, there are no right or wrong answers to this survey. It is for your own use to gauge your knowledge, skills and attitudes after the unit. Read the Knowledge, Skill or Attitude in the left column. Think about yourself: do you think you can do this? How well? Read the statements across the top. Put a check in column that best represents your situation.

My experience **Knowledge, skills, and attitudes**	**I don't have any experience doing this.**	**I know a little about this.**	**I have some experience doing this.**	**I have a lot of experience with this.**	**I am confident in my ability to do this.**
Describe and select the purposes of various crop maintenance practices					
Explain and compare the different types of crop maintenance practices					
Describe the methods and techniques for performing					

My experience Knowledge, skills, and attitudes	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
crop maintenance practices					
Practice crop maintenance practices					
Describe pests and diseases symptoms					
Identify damages based on pest and disease symptoms					
Explain and differentiate between the different types of damages due to pests					
Describe pesticide preparation and safety procedures					
Apply pesticides to control pests and diseases in food crops by following instructions					
Describe the different types of fertilisers					
Choose fertilisers following recommendations					
Describe techniques for applying fertilisers					
Apply fertilisers using recommended techniques					
Explain the steps needed to calculate the amount of fertiliser needed for a given field area					
Calculate the amount of fertiliser needed for a given field area					

2. Complete the table below by identifying areas from the unit where you have improved and where you need improvement with the actions/strategies you will use to help you improve when receiving and interpreting information at the workplace

Areas of strength	Areas for improvement	Actions to be taken to improve
1. **2.**	**1.** **2.**	**1.** **2.**

Unit 3: Assisting with harvesting activities for food crops

Topics

3.1 Determining the maturity indices for food crops

3.2 Performance of harvesting operations

3.3 Packaging and transporting food crop produce

Unit Summary:

This unit describes the knowledge, attitudes, and skills required to assist in harvesting activities for food crops. Upon completion of this unit, the learners will be able to determine maturity indices for food crops, to perform harvesting operations and to pack and transport food crop produce with close supervision.

Self-Assessment: Unit 3

1. Look at the unit illustration. What do you see? What do you think this unit will be about? What topics might be covered?

2. Fill in the self-assessment below.

There are no right or wrong ways to answer this survey. It is for your own use during this course. Think about yourself: Do you think you can do this? How well? Read the statements across the top. Put a check in column that best represents your situation. At the end of this unit, we'll take this survey again.

My experience **Knowledge, skills, and attitudes**	**I don't have any experience doing this.**	**I know a little about this.**	**I have some experience doing this.**	**I have a lot of experience with this.**	**I am confident in my ability to do this.**
Describe and identify maturity indices for food crops					
Explain the growth stages for a crop					
Decide when a crop has entered its maturity or ripening stage					
Determine if different crops have reached maturity					
Describe the specific maturity indices for different crops					
Describe and select the materials, equipment, and tools used for harvesting food crops					
Describe various methods and operations for harvesting food crops					
Choose the method for harvesting food crops					

My experience Knowledge, skills, and attitudes	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Describe the methods used for packing crops after harvesting					
Perform packing of food crops					
Identify and select the materials, tools, and equipment for transporting produce					
Explain the difference between manual and mechanical transportation methods					
Determine the transportation method to use					

Topic 3.1: Determining the maturity indices for food crops

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

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

Topic 3.1 Task 1:

1. Individually reflect on a time you tried to grow something or imagine you are growing a food crop. Write your 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. Share your ideas with a partner and discuss your answers:
   a. How are they similar?

   b. How are they different?

3. As a class, discuss the concept of "maturity."
   a. What does this word mean?

   b. How does it apply to food crop production?

Problem Solving Activity

Topic 3.1 Task 2:

1. Maturity Indexing is the process of monitoring the physiological development of crops. Consider the following scenarios and discuss your 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. Match the crop growth stage to its definition by drawing a line between them. Then, put them in the correct order.

Growth Stage	Definition
Maturity/Ripening	An organism grows from a seed
Germination	Development of reproductive organs
Flowering	Ready to be harvested and consumed

Growth Stages:	**1.**	**2.**	**3.**

3. With your partner, read through **3.1 Key Facts** and do the following:

a. Compare the factors you 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**.

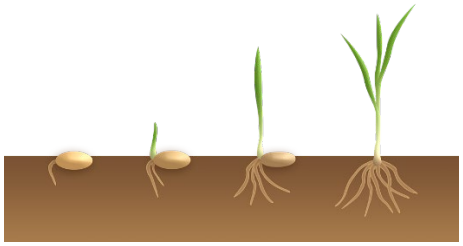
c. Discuss any questions you may have about the key facts. Ask the trainer for explanations and assistance.

3.1 Key Facts

- **Maturity Indexing**
  - Process of monitoring the physiological development of crops to determine when they are ready to be harvested
  - Parameters include internal quality, colour, water content, shape, surface characteristics, etc

- **Growth Stages** [17]
  1. **Germination:** An organism (commonly a seedling) grows from a seed
     - Seeds need warmth and water in order to germinate

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

 [18]

2. **Flowering:** Development of reproductive organs in the form of flowers, fruits, and seeds

3. **Maturity/Ripening:** Plant is ready to be harvested and consumed
   - Harvesting too soon before or too late after maturity may negatively affect the quality of the crop and result in financial losses

- **Physical Features**
  - **Size**
    - Applies to all fruits and many vegetables
    - Measure by sight and weight
  - **Shape**
    - Applies to bananas
    - Measure by dimensions and ratio charts (if available)
  - **Colour**
    - Applies to all fruits and most vegetables
    - Measure internal and external colouring by comparing colours using visual charts and by observing light reflections
  - **Surface Characteristics**
    - Examples: Gloss/waxiness, outer layer of melons
    - Measure by sight
  - **Abscission**
    - Natural detachments of parts of a plant, such as fruits
    - Applies to melons, apples
    - Measure by sight

    (Information from: Postharvest Technology of Horticultural Crops by Adel A. Kader; pages 56-59)

- **Examples:**

Crop	Maturity Indices
Grains	When leaves and pods have turned from green to yellow

[18] 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/

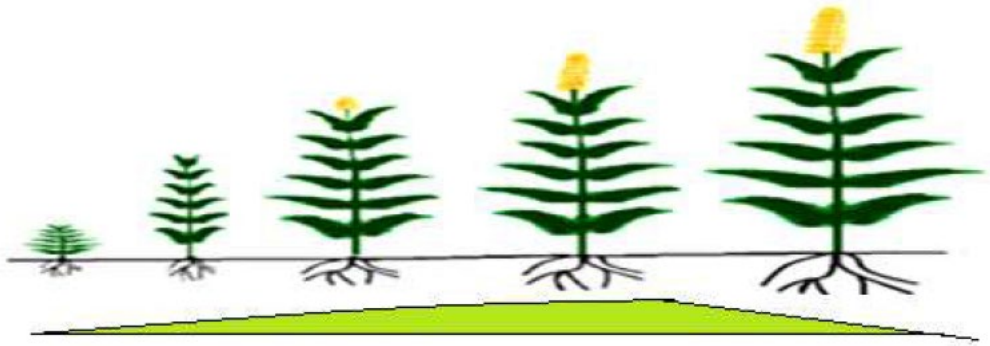
	Maize	When the plant has become light brown and the grain is hard When a black layer forms at the base of grains, where they connect with to cob.
	Sorghum and millet	When the stalks and most of the leaves are still green When the grains develop a black layer at their base
	Paddy Rice	When nine out of ten grains on the panicle are straw coloured When the grains have a moisture content of around 20-25%
	Potatoes	When leaves are dry, skins are set, soil is cracked
	Sweet Potato	When leaves are dry
	Cassava	When leaves begin to dry
	Plantain	Based on age, diameter, and shape of the fruit

Guided Practice Activity

Topic 3.1 Task 3:

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.

Flowering | **Maturity/Ripening** | **Germination**



19

[19] 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. Without referring to **3.1 Key Facts**, match the crop to its maturity index by drawing a line between them. **Grains** has been done as an example.

Crop	Maturity Indices
Grains	Leaves are dry
Maize	Based on age, diameter, and shape of the fruit
Sorghum and millet	Leaves and pods turn yellow
Paddy Rice	Leaves are dry, skins are set, soil is cracked
Potatoes	Grains develop a black layer at their base
Sweet Potato	Most grains on the panicle are light brown
Cassava	Grains develop a black layer at their base
Plantain	Leaves are dry

3. First, compare your responses with a partner. Then, verify your responses with the information in **3.1 Key Facts.**

4. Observe the photos of food crops provided by the trainer. Determine if each crop is mature or not yet mature. Be sure to defend your responses using evidence from **3.1 Key Facts** or other sources.

Application Activity

Topic 3.1 Task 4:

Visit a local food crop farm with your class.

1. Take a tour of the field.

2. While you are touring the field, determine approximately which growth stage the crops are in. Are they mature and ready to be harvested? Be sure to give evidence based on your observations. Note your findings in the chart below:

Crop	Growth Stage	Mature or Not Yet Mature?	Evidence

3. Verify your observations with the farmer.

4. After the tour, ask the farmer any remaining questions you have about maturing indexing for crops.

5. After the visit, discuss the following as a class:
   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?

Physical Feature	How to Measure
1.	1.
2.	2.

2. What is the purpose of maturity indexing?

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

1. **Potato =** ……..
2. **Cassava =** ……
3. **Maize =** …….

Circle the correct answer for each question.

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

Topic 3.2: Performance of harvesting operations

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

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

Topic 3.2 Task 1:

1. Think about how farmers harvest food crops produce. Individually brainstorm answers to the following questions. Write your answers below.
   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?

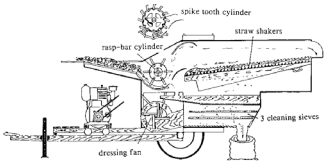
2. Share and discuss your ideas with a partner.
   ✓ Check or tick any answers that you both wrote.
   \+ Add any answers that your partner wrote, but you did not consider.

3. Volunteer to share your ideas with the rest of the class.

Problem Solving Activity

Topic 3.2 Task 2:

1. Using prior knowledge and experience, 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 below. **Sickle** has been done as an example.

Item	Image	Use
1. Sickle	**A** 	**i.** Lifts and moves materials short distances
2. Machete	***A*** 	**ii.** Trims and cuts, usually maize
3. Knife	***B***  Source: CIRAD [20]	**iii.** Reaps, threshes, and cleans in one operation

[20] 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

4. Thresher

C

iv. Trims and cuts

5. Combine Harvester

D

v. Everyday cutting and chopping

6. Forklift

E

vi. Removes seeds from stalks and husks

7. Sack

F

vii. Stores and carries goods

Item	Image	Use
1. Sickle	*E*	*ii*
2. Machete		
3. Knife		
4. Thresher		
5. Combine Harvester		
6. Forklift		
7. Sack		

2. 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, read through **3.2 Key Facts** with your partner. As you read, do the following:

a. Verify your answers to **Question 1.** The trainer will confirm the images.

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?

3.2 Key Facts

- **Harvesting**
  - The process of collecting mature crops from the field
  - Good harvesting increases yield and decreases damages

- **Tools, Materials, and Equipment**
  - **Consider**:
    - Cost
    - Harvesting method
    - Size of land
  - **Hand Tools**
    - Sickle: Used to cut or trim corn
    - Machete: Used for everyday cutting and chopping
    - Knife: Used to trim and cut
  - **Mechanical Equipment**
    - Thresher: Machine that removes seeds from stalks and husks
    - Combine Harvester: Machine that reaps, threshes, and cleans in one operation
    - Forklift: Machine that lifts and moves materials short distances
  - **Materials**
    - Tarpaulin (tarp): Large, waterproof cloth used to protect crops and equipment from sunlight, rain, and pests
    - Sack: Large bag made of strong material, used to store and carry goods
  - **Safety Precautions**
    - Ensure that fingers and other body parts are out of the way during cutting (knife and machetes) or lifting (forks)
    - Always wear personal protective equipment (PPE) as prescribed for the tools

- Always read the manufacturer's instructions
- Always be aware of all moving parts and ensure body parts do not become entangled
- Never use a tool or piece of equipment for any other use than what it was designed for

- **Preparation**
  - **Cleaning**
    - Must be cleaned and stored in a predetermined storage space
    - Must be kept dry and should not be kept on a dirt floor
    - Do not store near pesticides, pesticide application equipment, or fertilisers because equipment could become contaminated and then contaminate the harvested produce
    - Be sure to remove dirt and plant material stuck to the tools, remove microscopic particles including disease organisms, and sterilise equipment to eliminate all transmissible agents (bacteria, fungi and viruses)
    - Purpose:
      - Ensure that post-harvest decay organisms do not touch harvested produce
      - Prolong the life-span of tools and equipment

  - **Adjustment**
    - To change the settings to fit the needs of the crop and the user
    - Examples: power level, length of spikes, speed, height

  - **Calibration** [21]
    - To set the parameters of a machine
    - Examples: distance and temperature
    - Always read the manufacturer's manual/instructions for calibration methods and parameters
    - Do test runs and record data to ensure the machine has been properly calibrated

- **Methods**
  - Manual: Using hands or hand-operated tools
  - Mechanical: Using mechanically operated machines

[21] Farm Management. (n.d.). *Calibrating Your Machines Accurately for Harvest*. https://www.farmmanagement.pro/calibrating-your-machines-accurately-for-harvest/

Guided Practice Activity

Topic 3.2 Task 3:

1. Imagine you are growing maize at your farm. You need to select tools, equipment, and materials for harvesting the maize. In small groups, discuss and write answers to the following questions:

a. What factors will you consider before selecting the tools, equipment, and materials?

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

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

a.

b.

c.

2. Discuss the differences between manual and mechanical harvesting methods.

3. Read through **3.3 Key Facts.** Using the information in **3.2 and 3.3 Key Facts**, do the following:

a. Identify and write the advantages of manual and mechanical methods.

Advantages	
Manual	Mechanical

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

Disadvantages	
Manual	Mechanical

3.3 Key Facts [22]

Harvesting Operations

- **Reaping:**
  - To cut the grain or pulse for harvest; first harvesting operation
  - **Manual**
    - Tools: Sickles for higher crops, knives for lower crops
    - Advantages: Effective for crops that have been flattened (lodged)
    - Disadvantages: Labour-intensive
  - **Mechanical**
    - Tools: Reapers
    - Advantages: Low amount of labour needed
    - Disadvantages: Machine may be expensive and difficult to get

- **Threshing:**
  - To separate the grain from the straw by beating the grain against a hard object
  - **Manual**
    - Methods: Pedal thresher, trampling, threshing rack, flail
    - Tools: Hands, thresher, hard objects (drum, wooden platform)
  - **Mechanical**
    - Tools: Stationary machines
    - Reduce labour requirements compared to manual threshing

- **Cleaning:**
  - To remove unwanted materials from the grain
  - **Grain**
    - Winnowing: Blower removes lighter materials
    - Screening/Sifting: Move seeds through small screen to remove small materials
    - Benefits: Increases value, improves drying process, improves ability to be stored
  - **Seed**
    - Winnowing and sifting
    - Grading: Process seeds with a uniform size and weight
    - Purity: Prevent mixing with other types of seeds
    - Benefits: Reduces diseases damages, improves yields

- **Hauling:**

[22] Rice Knowledge Bank. (n.d.). *Harvesting*. http://www.knowledgebank.irri.org/step-by-step-production/postharvest/harvesting

- To move the cut crop to the threshing location
- Should try to minimize transport damage
  - Avoid rough roads if possible

- **Field Drying:**
  - To expose cut crops to sun by leaving it in the field
  - Can lead to lower quality and increased losses
  - Optional

- **Stacking/Piling:**
  - To temporarily store the harvested crop in stacks or piles
  - Can lead to lower quality and increased losses
  - Optional

- **Bagging:**
  - To put the threshed grain in bags for transport and storage
  - Proper bagging allows farmers to store their crops until prices increase

Application Activity

Topic 3.2 Task 4:

Visit a local farm with food crops that are mature.

1. Take a tour of the crop field.

2. Determine which of the harvesting operations are taking place.

a. Write a check or tick (✓) if an operation is happening on the farm.

b. Write an ✗ if the operation is not happening on the farm.

Harvesting Operation	✓ or ✗	Tools, Equipment, or Materials Used
Reaping		
Threshing		

Cleaning		
Hauling		
Field Drying		
Stacking/Piling		
Bagging		

3. After the tour, observe the farmer as he or she demonstrates how to clean, adjust, and calibrate a piece of equipment. If possible, take turns assisting the farmer in these processes.

4. Finally, ask the farmer the following questions, plus one of your own about harvesting operations.

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:	

5. After the visit, observe photos and videos of the different harvesting operations from **3.3 Key Facts.** Identify the specific operation. Then, discuss:

a. 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.

1. …… occurs when the crop is moved to the threshing location.

2. Threshing is the process of separating the …… from the …… by beating the grain against a hard object.

3. Sickles, knives, and …… are all used to cut crops.

Write answers to the following questions.

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

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

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

Topic 3.3: Packaging and transporting food crop produce

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

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

Topic 3.3 Task 1:

1. After harvesting food crops, they must be packed and transported to be sold. 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. Share your ideas with the rest of the class. Add any materials, tools, and equipment to your list that you did not include previously.

Problem Solving Activity

Topic 3.3 Task 2:

1. With your partner, brainstorm responses to the following questions:
   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?

2. Read through **3.4 Key Facts** and do the following as you 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:
     1.
     2.
     3.

3. After reading **3.4 Key Facts**, observe the images provided by the trainer of the different materials and equipment used for packing and transporting produce.

3.4 Key Facts [23] [24]

- **Selecting Packing Methods**
  - **Field Packing**
    - Primary selection of fruits and vegetables in the field
    - Remove products with diseases or defects
    - Involves less handling of produce
    - Lower costs

[23] 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
[24] 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

    - Fewer quality losses
    - Best method for perishable products and/or small amounts

- **Packing Shed**
    - Perform special operations on products indoors
        - Examples: colour sorting, waxing, controlled ripening, pest and disease control, temperature treatments, gas treatments
    - Similar to factory assembly line
    - Protection from weather
    - Large spaces for community associations, cooperatives, and organizations to use
    - Best method for large operation, distant markets, products that require special operations

- **Performing Packing Methods**
    - Handle with care
        - Directly affects quality and therefore selling price
    - Plan in advance
        - Goal is to sell to buyers or at the market as soon as possible after harvesting
        - Timing should meet market requirements
        - Contact buyers
        - Arrange labour, equipment, and transportation
        - Provide supervision
    - Train labour
        - Hire local workers
        - General: prevent damage and avoid contamination of produce
        - Specific: grading/evaluating, post-harvest special operations

- **Transportation Materials, Tools, and Equipment**
    - **Materials**
        - Sacks:
            - Advantages: Cheap, hold low weight and volume
            - Disadvantages: low protection, need to be stitched often
            - Best for hard produce, such as potatoes and onion
        - Wooden Crates
            - Advantages: Can be made locally, protected against weather, good ventilation
            - Disadvantages: Can become contaminated with fungi and bacteria, may be too hard for soft fruits, uses natural forest resources
            - Best for potatoes and tomatoes
        - Pallet Boxes

        - Advantages: Less manual handling and thus reduced costs, more efficient than smaller crates, faster
        - Disadvantages: Must invest in forklifts to empty, more produce injuries during filling and unloading
    - Trays/Buckets
        - Advantages: Low cost, material is available
        - Disadvantages: Difficult to clean, less protection of produce, difficult to load and organise
        - Best for transporting over short distances

- **Tools**
    - Used to fix materials before, during, or after transportation
        - Hammer and nails to fix wooden crates
        - Stitching tools to fix sacks

- **Equipment**
    - Vehicles: Trucks, wheelbarrows, bicycles
    - Forklift: Used to load and unload pallets

- **Transportation Methods**
    - **Manual**: Using hands or hand-operated tools
        - Wheelbarrows, bicycles
        - Higher risk for damage
    - **Mechanical**: Using mechanically-operated machines
        - Trucks
        - Preferred, especially for long distances
        - Must be packed properly to avoid damage

Guided Practice Activity

Topic 3.3 Task 3:

1. In small groups, consider the following scenario and write answers to the questions below. Be prepared to present your decision to the rest of the class. 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.

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

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

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

2. After responding to the questions above, prepare to present your decisions to the rest of the class. Each person in the group should have an opportunity to speak. Answer questions from the class after your presentation.
   a. Listen to other presentations and ask questions.

3. Discuss the correct answers with the trainer.

4. Identify any information you still need to know about packing and transporting food crops. Write down your questions so that you can ask them in **Task 4.**

Application Activity

Topic 3.3 Task 4:

Visit a local food crop farm during harvesting time with your class.

1. First, interview the farmer using the questions below as well as the ones you created about packing and transporting food crops in **Task 3**. Write the answers 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. Note the materials, tools, and equipment used for packing and transporting below.

Materials	Tools	Equipment

3. If possible, 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?

2. What are the advantages of pallet boxes?

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

Select **True** or **False** for the following statements.

- ❑ The goal for packing is to sell to buyers or at the market as soon as possible after harvesting.
- ❑ Sacks are cheap, but they can hold a lot of weight and volume.
- ❑ Wheelbarrows and bicycles are examples of manual transportation methods.
- ❑ Packing sheds are best used for perishable and/or small amounts of produce.

Self-Reflection

1. You have come to the end of the unit. You are going to do the survey you did at the beginning of the unit again to help you do self-assessment of your knowledge, skills and attitudes.

Again, there are no right or wrong answers to this survey. It is for your own use to gauge your knowledge, skills, and attitudes after the unit. Read the Knowledge, Skill or Attitude in the left column. Think about yourself: do you think you can do this? How well? Read the statements across the top. Put a check in column that best represents your situation.

My experience Knowledge, skills, and attitudes	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Describe and identify maturity indices for food crops					
Explain the growth stages for a crop					
Decide when a crop has entered its maturity or ripening stage					
Determine if different crops have reached maturity					
Describe the specific maturity indices for different crops					
Describe and select the materials, equipment, and tools used for harvesting food crops					
Describe various methods and operations for harvesting food crops					
Choose the method for harvesting food crops					
Describe the methods used for packing crops after harvesting					
Perform packing of food crops					
Identify and select the materials, tools, and equipment for transporting produce					
Explain the difference between manual and mechanical transportation methods					

My experience Knowledge, skills, and attitudes	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Determine the transportation method to use					

2. Complete the table below by identifying areas from the unit where you have improved and where you need improvement with the actions/strategies you will use to help you improve when receiving and interpreting information at the workplace

Areas of strength	Areas for improvement	Actions to be taken to improve
1. **2.**	**1.** **2.**	**1.** **2.**

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