RWANDA POLYTECHNIC

TVET LEVEL II

AGRICULTURE

Growing Medium

TRAINER MANUAL

RWANDA POLYTECHNIC

Approved by: Workforce Development Authority

USAID FROM THE AMERICAN PEOPLE

EDC Education Development Center

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Acknowledgements

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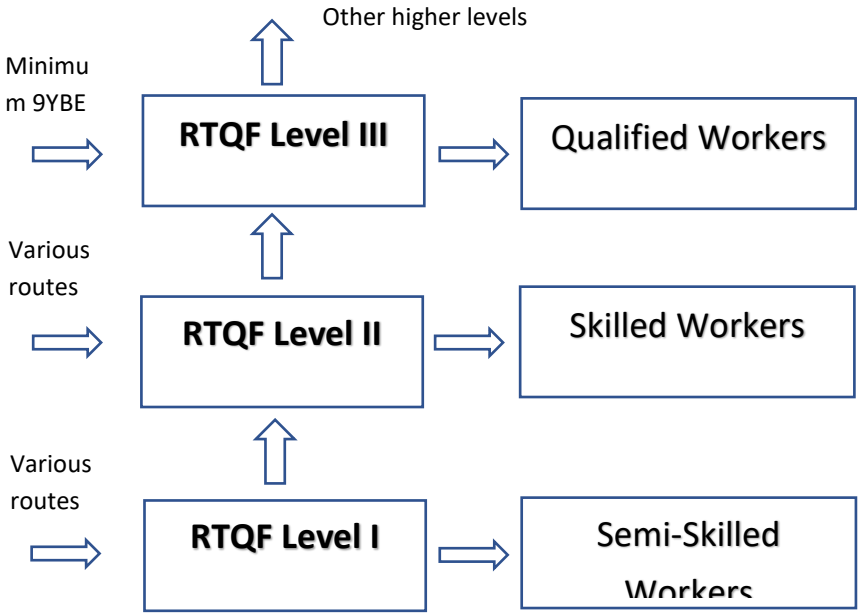
Introduction to RTQF Level II Training Modules

Background

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



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

Module Requirements:

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

• Integrated Science (Physics, Chemistry, Biology)	• Communication Skills • Safety, Health and Sustainable Environment • Personal Development and Career Guidance	E.g. Food Crop Production and Processing includes the following modules: 1. Food Crop Production 2. Small Scale Post-Harvest Operations 3. Growing Medium 4. Food Safety and Sanitation 5. Food Preservation and Storage 6. Flour Processing

Organization of the Training Manuals

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

Teaching & Learning Methodology of RTQF Level II 2 TVET Materials

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

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

- Applying social inclusion principles: Finding ways to include all types of youth (and trainers) – males and females; different cultural/ethnic/religious backgrounds, people with disabilities (PWD); people with different types of health status …

- Encouraging risk taking – promote questioning and being free to explore

- Promoting habits of mind that support life-long learning: curiosity and wonder, open mindedness, creativity

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

1. **Key Competencies:** Table found at the beginning of each Learning Outcome that describes the main knowledge, skills and attitudes to be gained by the end of the activities.

2. **Self-Assessment:** Conducted at the beginning and end of each Learning Unit to get a sense of trainees' knowledge and skills going into it and what they have gained by the end of the Learning Unit (and steps they need to take to further their understanding and skills).

3.  **Getting Started Activity:** Typically, a quick activity or questions to 1) give the trainer a sense of trainees' existing knowledge and skills; 2) spark the interest of trainees in the topic; 3) introduce the objectives and key competencies of the topic.

4.  **Problem Solving Activity:** A challenging activity to get trainees engaged and to learn through discovery instead of memorization of facts. A variety of teaching and learning methodologies are used, including individual and group work such as reading real life work-based scenarios and answering accompanying questions to activities such as identifying proper tools and equipment from the school workshop to conduct a certain activity. Following the sharing of responses, the trainer guides trainees through the content and processes being introduced.

5.  **Guided Practice Activity:** Building on the concepts and skills gained in the Problem Solving Activity, the trainer guides trainees through practical examples.

6.  **Application Activity:** Consolidates trainees' knowledge and skills through a real-life application of the topic in the classroom, community or workplace. Trainees are given more independence in applying what they have learned.

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

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

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

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

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

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

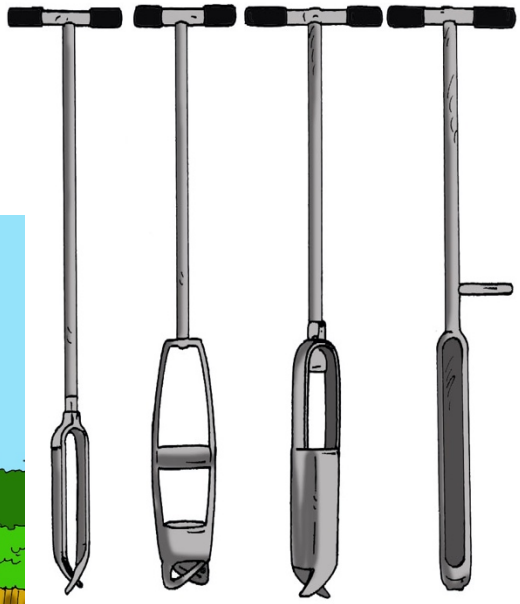
The Trainer's Manual includes answers (or guidelines to the trainer as appropriate) to Formative and Summative Assessments as well as to problems given throughout the activities. Summative Assessments are not included in the Trainee's Manual. These are meant to be used as a guide for those who will be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

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

GROWING MEDIUM

Learning Units	Learning Hours	Learning Outcomes
Learning Unit 1: Assist in collecting soil samples for laboratory testing	10	**1.1** Identify tools, materials, and equipment for soil sampling
		1.2 Clean tools and equipment for sampling
		1.3 Adjust tools and equipment for sampling
		1.4 Collect soil samples for laboratory testing
		1.5 Handle soil samples
Learning Unit 2: Assist in preparing soil samples for laboratory testing	10	**2.1** Select laboratory soil protocols and procedures
		2.2 Prepare soil samples
		2.3 Apply laboratory analyser recommendations
Learning Unit 3: Perform tillage for planting	20	**3.1** Select land for tillage
		3.2 Identify tools and equipment for tillage
		3.3 Identify tillage types
		3.4 Perform tillage
Learning Unit 4: Maintain soil	20	**4.1** Apply soil conservation measures
		4.2 Acquire amendments
		4.3 Prepare amendments
		4.4 Apply amendments
Learning Unit 5: Assist in sterilizing soil for organic growing medium	20	**5.1** Identify soil for organic growing
		5.2 Identify tools and equipment for soil collection and sterilization
		5.3 Treat soil for growing medium
Learning Unit 6: Assist in setting up growing medium for planting	20	**6.1** Identify materials of growing medium
		6.2 Prepare growing medium
		6.3 Place sterilized soil and amendment in growing medium
Learning Unit 7: Assist in setting up water delivery systems for growing medium	20	**7.1** Identify materials, tools, and equipment for water supply systems
		7.2 Install water supply system
		7.3 Watering according to the crop water requirements

Learning Unit 1: Assist in collecting soil samples for laboratory testing



Learning Outcomes

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

1.1 Identify tools, materials and equipment for soil sampling

1.2 Clean tools and equipment for sampling

1.3 Adjust tools and equipment for sampling

1.4 Collect soil samples for laboratory testing

1.5 Handle soil samples

Learning Unit 1 Self-Assessment

1. Ask trainees to look at the illustrations above (in their Trainee Manuals) and discuss what they see. What topics do they think this unit will include based on the illustrations? After some brainstorming, share the main topics.

2. Explain that this Learning Unit is going to focus on soil sampling, including why we do soil sampling, the tools we use, and how we collect and handle soil samples.

3. Ask trainees to fill out the self-assessment at the beginning of the unit in their Trainee Manuals. Explain that the purpose of the self-assessment is to become familiar with the topics in the unit and for them to see what they know or do not know at the beginning. At the end of the unit, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas that need improvement and actions to take. The self-assessment is not a test!

Learning Outcome 1.1: Identify tools, materials and equipment for soil sampling

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

a. List keys factors for good soil sampling tool and equipment

b. State the characteristics of tools, material and equipment for soil sampling

c. Choose good tools, material and equipment for soil sampling

Time Required: 2 hours

Learning Methodology: small and large group discussion (using scenarios, illustrations, soils sampling tools and equipment, question and answers); case study/scenario; brainstorming; oral presentation of individual/group work

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper
- **Soil sampling tools and equipment -** hoe, forked hoe, shovel, machete, saws, pick, ropes, Personal Protective Equipment (PPE), soil augers, soil probes, soil sampling kit if available (contains augers, extensions, cross handles, probe, probe tips, cleaning brush, wrenches, etc.)
- **Soil sampling materials:** containers, plastic bags, brown paper/newspapers

Preparation:

- ❑ Take or find additional photos and pictures of soil sampling equipment, tools and material.
- ❑ Gather and arrange soils sampling equipment, tools and materials from the school workshop.

Cross Cutting Issues:

- ✓ **Standardization culture:** Emphasis is placed on the need to use equipment/tools/materials that meet soil sampling requirements such as being clean, robust and made of the right materials.
- ✓ **Environment and sustainability:** One of the scenarios links soil sampling and soil contamination from waste, including safety requirements.
- ✓ **Gender and inclusivity** in forming groups and allocating roles

Prerequisites:

- None

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe the importance of soil sampling	**1.** Provide information to others on how soil sampling is necessary to identify nutrients in the soil	**1.** Self confidence
2. State the general requirements of equipment, tools, and materials for reliable soil sampling	**2.** Choose equipment, tools, and materials for soil sampling that meet quality standards	**2.** Attention to detail and quality standards
3. Identify key factors related to soil, weather and terrain to consider when selecting equipment, tools, and materials for soil sampling	**3.** Select equipment, tools and materials based on factors related to soil, weather and terrain	**3.** Analytical

Steps:

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

1. Ask trainees to turn to **Topic 1.1 Task 1** in their Trainee Manuals. With the person next to them they should:

- **a.** Look again at the pictures at the beginning of the unit. What is soil sampling? How would you describe it to someone?
- **b.** Share any experiences, if any, they have had with soil sampling. Where did they do it? How? Why?

c. Discuss why soil sampling is important in crop production. How might taking care of the soil be similar to taking care of one's body? What purpose does soil testing serve?

Possible Answer: Soil sampling is a process of gathering soil for analysis. It shows you the nutrients in the soil that are available to the plants you are growing. Like the human body, plants need nutrients to grow well. They need nitrogen (N), phosphorus (P) and potassium (K) as well as small amounts of boron (B) and zinc (Zn). When there is not enough of these nutrients, the plants will not grow well. Farmers can add compost and fertilizers to the soil to make it richer in nutrients. Nutrient levels in soil can vary from year to year.

2. Ask a few volunteers to share their responses with the large group and discuss. Emphasize the importance of soil sampling as described above.

Problem Solving Activity

1. Ask trainees to find a partner and look at the pictures found in **Topic 1.1 Task 2**. Explain that the pictures represent different tools, equipment and materials used in agriculture. Their task is to:
   a. Circle the pictures they think are related to the tools, equipment and material used in soil sampling.
   b. Name the items they circle and discuss how they might be used in soil sampling.
   c. List features of a good soil sampling tool.

Possible Answers to a and b: a) trowel or hand shovel, b) auger, c) tractor, d) auger, e) soil, f) rake, j) auger, g) watering can, h) measuring wheel, i) plastic bag for soil sample, j) shovel, k) containers for soil samples, l) box for samples

Possible Answers to c: Sampling tools must meet these general requirements:

- Be robust enough to withstand handling operations;
- Be clean (free of dirt and rust);
- Be easy to clean;
- Conform to safety requirements;
- Be uncontaminated (stainless steel or chrome-plated tools to avoid contaminating sample with traces of chemicals; avoid brass, bronze or galvanized tools);
- Be approximately uniform in cross section to the desired depth

- Provide reproducible sampling units

Note: Gather additional photos or illustrations to supplement those found in the Trainee's Manual. If possible, bring some samples of the tools and materials from the workshop to the classroom to show them to trainees.

2. Ask for volunteers to share their responses to the questions a and b and discuss.

3. Explain that there are different tools used to collect soil samples. The tools used will depend on the availability and the type of soil. The soil probe and tubular soil sampler (*illustration a and o*) are basic sampling tools typically used to collect shallow samples while the different types of auger dig deeper. Examples of augers include the screw auger (*illustration j*), post hole auger (*illustration d*), tube auger, sheathed auger, clay/sand/mud augers… What is used will depend on what is available and the type of soil one is digging into.

4. Ask what other tools could be used if augers and probes are not available (e.g. spoon, knife, cutlass…).

5. Ask volunteers to share their answer to question c on the features of a good soil sampling tool. Supplement their answers as needed. Emphasize that the tools need to be clean and free of contaminants. Refer trainees to **1.1 Key Facts** in their manuals.

Guided Practice Activity

1. Ask trainees to form small groups of 4 – 5 people and guide them to do **Topic 1.1 Task 3**. Tell them a school neighbour wants to collect soil samples but needs advice on the types of equipment/tools/materials to use and how to select them. Before giving the neighbour advice, go to the school workshop to become more familiar with the tools. Perform the following tasks and/or answer the questions:

a. Gather the equipment/tools/materials that you would advise the neighbour to use in soil sampling. List the items.

Answer will depend on what is available in the school workshop but should include those discussed in the Problem Solving Activity and listed in **1.1 Key Facts**.

b. Observe the soil probes and augers in the workshop. Write down 3 observations. For example - What materials are the tools made up of? What are the main parts of the tools?
Answer: See **1.1 Key Facts** for information on probes and augers.

c. Determine whether the equipment/tools/materials are in good condition to be used for soil sampling. If not, identify what actions need to be taken to improve the quality.
Answer will depend on what is available in the school workshop but should include the elements listed above under Problem Solving Activity, Step 1c.

d. What factors would you advise your neighbour to consider when identifying tools and equipment for soil sampling?
Answer:
- Background of the field (type of crop grown previously, deep rooting crop or not, …)
- Field accessibility (near the road for example)
- Climatic conditions (rainy or dry season)
- Soil condition (soil texture and structure types – sandy, clay, gravel…)
- Availability of equipment, tools and materials (that will not contaminate the sample

Note: Trainees may not be able to answer all the questions correctly, but let them share their ideas and discuss as group members.

2. Ask group representatives to present their responses and discuss after each question.
- **a.** Take the time to show and explain the equipment/tools/materials in **questions a and b**. Pass them around so trainees can become familiar with them. Use and refer trainees to **1.1 Key Facts** to point out the features of probes and augers.
- **b.** Emphasize that tools need to be robust (strong), clean, and uncontaminated in **question c**.
- **c.** Supplement the responses given by trainees for **question d** on factors to consider when selecting tools to include the information above and in **1.1 Key Facts**.

Application Activity

1. Before class, arrange soil sampling equipment, tools and materials in the workshop. Some should meet the standards of good quality equipment, tools, and materials, and others should not (not clean, falling apart, possibility of contamination).

2. Divide trainees into small groups of 4-5 people and guide them to do **Topic 1.1 Task 4**. Ask trainees to read the following case and answer the questions:

   A cooperative in Nyamagabe District grows Irish potatoes, and the yield is decreasing day by day. The agronomist advised the cooperative to send a soil sample to the laboratory to see if the problem relates to the soil properties (chemical properties). The soil is sandy, and the field used to be a site where factories could dump their waste.

   You are going to assist the cooperative in identifying the equipment, tools, and materials needed to collect the soil sample. These are available in the cooperative's workshop. The condition of the equipment, tools and materials varies, however. Some do not meet the standards needed to collect reliable soil sample.

   a. List the criteria for good soil sampling equipment, tools and materials.
   b. Based on the criteria in question a, sort the equipment, tools and materials that are good for soil sampling and that are not good. Give the cooperative a list of those you recommend they use.
   c. Explain to the cooperative the other factors they should consider when choosing their equipment, tools and materials. Write these down on paper.
   d. Given the information provided about the field, what type of auger do you think should be used? What materials should be used to ensure safety requirements are met?

   Possible Answers:
   a. See list in **1.1. Key Facts** (clean, robust…)
   b. Will depend on what is available in the school workshop and how the trainer arranges the equipment/tools/materials.
   c. See list in **1.2 Key Facts** (background of field, type of soil…)
   d. Sand auger or standard auger; safety gloves in case there are chemicals or other toxins from former dumping site.

3. Ask group representatives to present their responses and discuss after each question. Fill in any gaps and answer any questions trainees may have.

Points to Remember

- Just like humans, plants need nutrients to grow! These nutrients are found in the soil.
- Soil sampling tells us what nutrients are needed in the soil for plants to grow better.
- Tools, equipment and materials must conform to safety requirements, be well-made, clean and easy to clean and resistant to reacting with whatever is being used in the testing.
- Always clean tools and equipment after use.
- When choosing equipment/tools/materials for soil sample, also consider the background, accessibility and condition of the field, type of soil and the physical/chemical makeup of the tools, materials and equipment.

Formative Assessment

1. Answer the following questions using **true** or **false**.

a. Soil sampling helps determine when to plant. (**Answer:** false)

b. It is necessary to consider the physical and chemical makeup of materials, tools and equipment when selecting such items for soil sampling. (**Answer:** true)

c. Soil sample tools can be used several times in different fields before cleaning. (**Answer:** false)

d. Soil type should be taken into consideration when identifying soil sampling tools, material and equipment. (**Answer:** true)

2. Ask trainees to go in the school workshop where there are different soil sampling tools and equipment. Ask them to:

a. Identify the ones which meet the requirements for soil sampling.

b. Explain why you chose the selected tools, materials and equipment.

Answers: The requirements for soil sampling tools, material and equipment are as follows:

- Be robust enough to withstand handling operations;
- Be clean (free of dirt and rust);
- Be easy to clean;
- Conform to safety requirements;
- Be uncontaminated (stainless steel or chrome-plated tools to avoid contaminating sample with traces of chemicals; avoid brass, bronze or galvanized tools);
- Be approximately uniform in cross section to the desired depth
- Provide reproducible sampling units

ⓘ Further Information for the Trainer

1. Admin. (2018, June 6). Difference Between Equipment and Materials. Retrieved December 6, 2019, from https://www.differencebetween.com/difference-between-equipment-and-vs-materials/.
2. Features of the Best Soil Sampling Tools. (2019, March 18). Retrieved December 6, 2019, from https://www.certifiedmtp.com/blog/best-soil-sampling-tools/.
3. Soil Sampling Equipment. (n.d.). Retrieved December 6, 2019, from https://www.globalgilson.com/soil-sampling-equipment.
4. (n.d.). Retrieved December 6, 2019, from http://www.fao.org/3/w7295e/w7295e07.htm.

Learning Outcome 1.2: Clean tools and equipment for sampling

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

a. Identify decontamination methods
b. List cleaning and sanitization steps
c. Select appropriate cleaning and sanitizing products
d. Disinfect / sterilize tools materials and equipment for soil sampling

Time Required: 2 hours

Learning Methodology: Demonstration; practical exercises on disinfection and sterilization; group discussion on decontamination methods; small group discussion/work; individual work

Materials Needed:

- **Standard training materials -** flip chart, markers, tape, A4 paper
- **Soil sampling tools and equipment -** hoe, forked hoe, shovel, machete, saws, pick, ropes, Personal Protective Equipment (PPE 0 gloves, goggles, etc.), soil augers, soil probes, soil sampling kit if available (contains augers, extensions, cross handles, probe, probe tips, cleaning brush, wrenches, etc.)
- **Soil sampling materials -** containers, plastic bags, brown paper/newspapers
- **Detergents and cleaners -** for trainees to practice using (if possible)

Preparation:

- ❑ Plan to visit the school workshop to see available tools and materials used in cleaning.
- ❑ Prepare the school workshop in advance and make sure there is equipment to be cleaned along with the appropriate cleaning materials.

Cross Cutting Issues:

- ✓ **Gender and inclusivity**: Through for formation of learning groups
- ✓ **Environment and sustainability**: Being mindful and resourceful when disposing residues from cleaning
- ✓ **Financial education:** When selecting equipment and materials, one should use the least expensive yet effective materials to prepare their equipment

Prerequisites:

- Knowledge of tools and material used to clean sampling tools and equipment
- Basic chemistry knowledge regarding handling chemicals
- Knowledge of safety and environmental protection

- Knowledge of negative effects of chemicals on environment

Key Competencies:

Knowledge	Skills	Attitudes
1. List cleaning and sanitization steps	**1.** Apply appropriate decontamination methods based on tools and equipment being used	**1.** Hard working
2. Identify decontamination methods	**2.** Select appropriate cleaning and sanitizing products	**2.** Reliable
3. Identify appropriate cleaning and sanitizing products	**3.** Disinfect / sterilize tools, materials and equipment for soil sampling	**3.** Realistic

Steps:

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

1. To start a discussion, ask the trainees the following:
"*What is the difference between washing your hands with water and washing your hands with soap and water?*"

2. Ask trainees to turn and talk with a partner what they think the definitions are of disinfect, decontaminate, and sterilise. If they need help, read to them the following sentences to provide context of the meanings:
   a. "Always **sterilise** the needle to prevent infection."
   b. "Chemicals were added to **disinfect** the water." "The boy's cuts and scrapes needed to be **disinfected**."
   c. "The cook had to **decontaminate** the surface after he cut his finger with the knife."

3. Ask the trainees to discuss some examples of things that should be decontaminated, sterilised, and/or disinfected on a regular basis before or after using (food, eating utensils, bathrooms, floors, people, animals, medical equipment, etc.).

4. Write the trainee's ideas on the board/flipchart and facilitate a class discussion.

5. End the discussing and brainstorm by introducing the learning outcome and direct the trainees to turn to and read the Key Competencies table in their Trainee Manuals before moving on.

Problem Solving Activity

1. Divide the trainees into groups of four or five.

2. Direct the trainees to read and respond to **Topic 1.2 Task 2**:
   Alice recently started working for an organisation that supports farmers. To determine what type of fertilisers to use in a farming area, the organisation is going to collect soil samples. Alice's supervisor has asked her to prepare the necessary tools and equipment to take samples.

   Give Alice some guidance by answering the following questions:
   a. Why do you think Alice needs to be careful about contaminating soil samples? How would she prevent possible contamination?
      Answer: Alice needs to be careful about contaminating soil sample because she will need the results to be accurate.
   b. If you were Alice, what are the steps you would take in cleaning and sanitizing the tools and equipment?
      Answer:
      - Flush or sweep surfaces to remove gross soil.
      - Wash the surface with the appropriate cleaning compound.
      - Flush the cleaner from the surface.
      - Apply a sanitizer
      - Flush the sanitizer
      - Dry the equipment

3. If you need to, define contamination for the trainees as follows: To contaminate something is to make it impure, or to pollute by poisoning it.

4. After the trainees have discussed **Topic 1.2 Task 2** in groups, as a class, ask them to list the types of cleaning products they are familiar with.
   Possible Answers: detergents, degreasers, soaps, bleach, etc.

Guided Practice Activity

1. Before moving to the next activity, read through all **1.3 Key Facts** with the trainees, pausing after each one to ask questions and to ensure that the trainees understand the terminology used.

2. Direct trainees to go back to **Topic 1.2 Task 2** to revise their answers according to the information provided in **1.3 Key Facts**. Ask a few volunteers to share the changes they made.

3. Refer to **Topic 1.2 Task 3** for the trainees to complete in groups of 4 or 5:

   Claude is a new employee at Farm Tech, a company that helps farmers in rural areas. One of his first assignments is clean and organize a workshop containing soil sampling equipment he and his team will be using in the field.

   a. Provide Claude some tips for how and why he should always keep the workshop organized.

   Answer: Organizing your workshop and equipment helps everything stay clean and organized, helps you remember where things are, and allows you to keep an accurate inventory of your supplies and equipment.

   b. Explain to Claude what the steps are to properly clean and sanitize equipment.

   Answer: Refer to **1.3 Key Facts – Basic steps for cleaning and sanitizing.**

   c. Claude is considering using an acid to clean the stainless-steel soil probe and hand shovels. Is this a good idea, why or why not?

   Answer: Using an acidic compound to clean stainless steel equipment is not a good idea because according to **1.3 Key Facts**, stainless-steel will corrode (break down)

when exposed to strong alkalis, acids, or chlorine. Claude should use a mild, nonabrasive cleaner such as, a paste of baking soda and warm water, or a compound specifically manufactured to clean stainless-steel equipment.

4. As groups are discussing and writing their answers, move around to help facilitate more discussion. For example, *"Why do you think that?"*

5. After the groups have had enough time to discuss and write their responses, ask several volunteers to share their groups' responses to the class.

6. Use your answer guide to read and explain the correct responses if the trainees' responses are not sufficient/accurate.

Application Activity

1. Divide the trainees into groups of 4-5 people and bring them to the school workshop to complete **Topic 1.2 Task 4.** Be sure they understand the instructions before beginning to activity.

a. Separate the equipment that needs to be cleaned with the equipment that does not need to be cleaned.

b. With your group, clean the dirty tools and equipment using the appropriate and available cleaning product. First discuss with your group which cleaning compounds you will use for the different equipment and then receive approval from your trainer before beginning.

c. Write a short report describing the tools and equipment your group inspected and cleaned, the cleaning products used, and the steps used in cleaning.

2. During the activity, move around to each group for supervision and ensure that each group checks in with you regarding the cleaning compound used and which equipment they plan to sanitize.

3. At the end of the activity, remind trainees to clean and organise the space appropriately before leaving and have a member from each group present their reports from **part c**. Encourage other groups to ask questions and provide feedback.

4. Thank the groups and offer your observations and feedback.

Points to Remember

- Decontamination includes, cleaning, disinfecting, sterilizing, and using antiseptics.
- Clean your tools before and after every use.
- Store and organize your tools properly.
- Always use the appropriate cleaning products for the equipment material/surface.

Formative Assessment

Inform the trainees that the following assessment is to be done individually:

1. Explain what kind of cleaners should be used for stainless steel equipment. Why?

2. Complete the following sentence:
If I clean my tools and equipment after every use, then _____.

3. Explain the importance of decontamination.

4. Answer by identifying each statement as **true** or **false**.
   a. Sterilization is not a form of decontamination.

   b. Methods of decontamination include, wet heat, dry heat, liquid disinfection, and vapors and gases.

   c. Rust can be good for your tools.

   d. Hanging your tools is not a good strategy for staying organized.

Answers:

1. For stainless steel, use mild, non-abrasive cleaners.

2. …then I will save money/ then my tools will look better/ then my tools will last longer.
3. Answers should include information about: killing/removing harmful bacteria, keeping the farm and the workers healthy and safe, etc.
4. a. False
   b. True
   c. False
   d. False

ⓘ Further Information for the Trainer

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Learning Outcome 1.3: Adjust tools and equipment for soil sampling

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

a. Identify causes of malfunctioning tools and equipment
b. Identify adjustment guides lines
c. Separate tools and equipment with reference to their working conditions
d. Perform minor adjustments on tools, materials, and equipment

Time Required: 2 hours

Learning methodologies: Brainstorming the causes of malfunction of tools and equipment; small group discussion on adjustment guidelines; individual work on adjustment guidelines; practical exercises

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper
- **Tools and equipment -** small squares of sandpaper, pieces of wood (handles or small cut boards), linseed oil, hoe, forked hoe, shovel, machete, saws, pick, ropes, personal protective equipment (PPE – gloves, goggles, etc.)
- **Soil sampling materials -** soil augers, soil probes, soil sampling kit if available (contains augers, extensions, cross handles, probe, probe tips, cleaning brush, wrenches, etc.)

Preparation:

- ❑ Prepare all materials and activities in advance
- ❑ Confirm that the school workshop has tools and equipment to be inspected by trainees – power tools, tools and equipment with wooden handles, blades, moving parts, etc.

Cross Cutting Issues:

- ✓ **Standardization culture:** Emphasize the need to use equipment, tools, and materials that meet soil sampling requirements such as being clean, robust, and made of the right materials.
- ✓ **Environment and sustainability:** Link one of the scenarios to soil sampling and soil contamination from waste, including safety requirements.

Prerequisites:

- General knowledge of care and maintenance of tools and equipment

Key Competencies:

Knowledge	Skills	Attitudes
1. List the causes of malfunctioning tools and equipment	**1.** Separate tools and equipment in good working condition from those in bad working condition	**1.** Team spirit
2. Identify causes of malfunctioning tools and equipment	**2.** Take care of tools and equipment used in soil sampling	**2.** Analytical
3. List the adjustment guidelines for tools and equipment	**3.** Perform minor adjustments of tools and equipment used in soil sampling	**3.** Careful

Steps:

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

1. Ask trainees to discuss with their partners what they think they know about the following questions, found in **Topic 1.3 Task 1** in their manuals:

a. What does it mean to **adjust** something?

b. How do you know if it is ok to use a piece of equipment or not? What should you look for?

Answers: Adjust. (Verb) to alter or move (something) slightly in order to achieve the desired fit, appearance, or result.

2. After five minutes of discussion, facilitate a group discussion about the answers to the questions. Ask volunteers to share what they think and why they think that.

3. Introduce the learning outcome and direct the trainees to look at the table of knowledge, skills and attitudes in their Trainee Manuals. Introduce to the class that this learning topic will focus on properly adjusting one's tools for soil sampling.

Problem Solving Activity

1. Ask the trainees to form groups of 4-5 people. Read the scenario and questions from **Topic 1.3 Task 2:**

Ganza wants to collect a soil sample using sampling tools and equipment. In the workshop, however, he realized that among the available tools and equipment, there are some that are in good working condition and others that are in bad condition. He decides to sort the tools into two sections: **ready to use** and **need adjustments before using**.

a. With your groups, discuss and write what Ganza should be looking for when sorting the tools and equipment.

b. Discuss and explain: What could cause different tools and equipment to need servicing, cleaning, and adjusting before using?

Answer: Possible faults on tools and equipment used in soil sampling are as follows:

- Loose joints/parts
- Cracked, or splintered handles
- Corroded tools/equipment (rust)
- General wear and tear of tools /equipment – natural aging of equipment

Causes of faults on tools and equipment used in soil sampling:

- Loose connections
- Dust
- Moisture or high humidity
- Supply line surges (electrical surges)
- Insulation deterioration
- Overload conditions
- Poor storage
- Never cleaned not cleaned properly

2. Some of them may not be able to discover the answers but let them to share their ideas and help other group members.

3. Ask volunteers to present their responses with the class. Encourage the trainees to ask questions and provide feedback where necessary.

4. Inform the trainees that after discussing **1.4 Key Facts** as a class, they will return to **Topic 1.3 Task 2** to check and revise their knowledge.

Guided Practice Activity

1. Before the next activity, read through all of **1.4 Key Facts** with the trainees, pausing after each one. Encourage trainees to ask questions and use this time to discuss the content in **1.4 Key Facts**.

2. After reading and discussing **1.4 Key Facts**, direct the trainees to check their answers from the first two activities **(Topic 1.3 Tasks 1 and 2)** with the information provided in the **1.4 Key Facts**.

3. Ask a few volunteers to share the correct answers the questions from **Topic 1.3 Task 2** according to the information in **1.4 Key Facts:**
   a. With your groups, discuss and write what Ganza should be looking for when sorting the tools and equipment.

   b. Discuss and explain what could cause different tools and equipment to need servicing, cleaning, and adjusting before using.

4. Now, direct the trainees to form groups of three and provide each trainee (if possible-- if not, provide each group) with a square of sandpaper, a wooden handle/pole/small board of wood, and some linseed oil for polishing the wood after repairing.

5. Model how to properly inspect a tool with a splintered or cracked wooden handle, adjust/fix it by sanding it down, and polish it with linseed oil (all according to the information provided in **1.4 Key Facts - Adjustment techniques and procedures**).

6. Direct the trainees to **Topic 1.3 Task 3** in their manuals. Tell them to observe each other properly sand a piece of wood/wood handle and ensure that it has no harmful cracks or splinters for anyone who will be touching it.

7. Walk around the classroom, stopping at each group to ask trainees to demonstrate and explain their process of inspecting, sanding, and oiling the wood.

8. Bring everyone together to discuss the process and share their written explanations of the process in their own words. Provide your observations and feedback.

Application Activity

1. Bring the trainees to the school workshop or have tools and equipment in the classroom for them to inspect. If possible, try to have tools and equipment that need to be adjusted and serviced.

2. Refer to Topic **1.3 Task 4** in the Trainee Manual and give time to the trainees to fill out the table provided.

3. Walk around and assist the trainees as needed. If some tools and equipment do not appear to need any adjustment, explain to the trainees that they should still make a recommendation for preventative measures and keep the tools/equipment in good working condition.

4. At the end of the activity, ask several trainees to stand next to a piece of equipment that they put in their table from **Topic 1.3 Task 4** and read what they put for that piece of equipment. Encourage others to ask questions and provide comments on others' work.

Points to Remember

- Causes of malfunctioning of tools material and equipment include loose connections, dust, moisture or high humidity, overloaded conditions, cracked housing, and corrosion and rust.

- Inspect and repair your tools every time you use them.

Formative Assessment

1. What are five causes of malfunctioning equipment?
   1.
   2.
   3.
   4.
   5.

2. Why is it important to inspect equipment before using it?
   Complete the following sentences:

3. If a wooden handle is damaged, you should _____ .

4. If your power tools are damaged, you should _____ .

5. Answer by identifying each statement as **true** or **false**:
   a. A dull blade is perfectly safe to use.

   b. Rust can be scrubbed off with the correct cleaning compound.

   c. Overtime, tools and equipment will naturally break down and fall apart.

Answers:

1. Refer to **1.4 Key Facts**.

2. Response should include information on saving money and/or having longer lasting equipment.

3. ……you should repair it by sanding it down and oiling it because it is prone to breaking and causing injury to others and/or you should carefully inspect it to see if it can be properly repaired.

4. …..you should get them repaired by a professional.

5. a. False
   b. True
   c.True

ⓘ Further Information for the Trainer

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3. TOOL FAILURES -CAUSES AND PREVENTION. (n.d.). Retrieved December 7, 2019, from https://www5.kau.se/sites/default/files/Dokument/subpage/2010/02/93_1343_1362_pdf_76008.pdf.

Learning Outcome 1.4: Collect soil samples for laboratory testing

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

a. Describe soil sampling methods
b. List the steps used in soil sampling
c. Collect soil for laboratory testing

Time Required: 2 hours

Learning Methodology: Small group discussion, large group discussion (using scenarios, illustrations, and questions and answers), case study/scenario, brainstorming, oral presentation of individual/group work, field work application

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper
- **Soil sampling tools -** hoe, forked hoe, shovel, machete, container, hand auger, plastic bags, wash basin, scoop wheelbarrow, tractor, vehicle, brushes, PPE gloves, measuring tape, ropes

Preparation:

- ❑ Obtain and prepare all materials and activities in advance
- ❑ Prepare a nearby field for the trainees to practice taking soil samples on with all necessary equipment

Cross Cutting Issues:

- ✓ **Standardization culture:** Emphasize the need to use equipment, tools, and materials that meet soil sampling requirements and to properly adhere to standards regarding the collection of soil samples.
- ✓ **Environment and sustainability:** The scenarios and Key Facts of this learning outcome emphasize the important of preventing erosion and soil health.
- ✓ **Gender and inclusivity:** Consider gender balance when forming groups and allocating roles.

Prerequisites:

- Working knowledge of soil sampling tools and equipment
- Basic measurements

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe soil sampling methods	**1.** Apply soil sampling methods	**1.** Team spirit
2. List sampling strategies	**2.** Apply soil sampling procedures	**2.** Analytical
3. Explain soil sampling guidelines	**3.** Collect soil samples	**3.** Careful

Steps:

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

1. Facilitate a group discussion on the following questions:

a. What do you think the importance is of soil sampling?

b. Under what circumstances would you need to test the soil of a location?

Possible Answers:

a. To know the quality of the soil and how it will affect your crops.

b. Site location for crops, site location for animals, quality control, etc.

2. Write all ideas on the board/flipchart.

3. Introduce the topic and direct students to the Key Competencies table in their Trainee Manuals. Inform them that this topic will focus on collecting soil samples for laboratory testing.

Problem Solving Activity

1. Ask trainees to read the scenario found under **Topic 1.4 Task 2** in their manuals with a partner:

Agricultural production takes place on many different types of soil. When cultivating season after season, the soil begins to lose some of its fertility and crop production

decreases. As a result, it is advised to analyse the soil in order to see what is in the soil and what to incorporate so that production can be increased.

a. What do you think are the factors that cause a soil to lose its fertility and cause crop production to decrease overtime?

b. Based on what you know, how do you think you can prevent or save the soil from losing its productivity?

2. Some of the trainees may not have the experience to answer to the questions. Let them share their ideas with each other. Ask group representatives to present their responses.

3. Inform the trainees that they will return to this activity after discussing **1.5 Key Facts** to revise their answers.

Guided Practice Activity

1. First, read through each of **1.5 Key Facts** with the class, pausing after each one to ask questions and make sure the trainees understand the terminology.

2. Ask the trainees to return to their answers from **Topic 1.4 Task 2** and revise their answers based on the information provided in **1.5 Key Facts.**

a. What do you think are the factors that cause a soil to lose its fertility and cause crop production to decrease overtime?

b. Based on what you know, how do you think you can prevent or save the soil from losing its productivity?

Answers:

a. Soil can lose its fertility due to a farmer repeatedly removing plants and crops, water soaking other nutrients into the soil overtime, organic matter such as compost not being replenished, and the structure of the soil eroding over time due to being compacted by equipment, or through erosion.

b. Replenish organize matter, such as compost, to soil before it decays.; don't let the soil become too compact and use cover crops to capture and keep nutrients present in the soil.

3. Ask the trainees to share their revised answers with the class. If they need assistance, provide example answers on the board or flipchart.

4. Now, ask trainees to form groups of 4-5 people and read the scenario and questions from **Topic 1.4 Task 3:**

   Imogene is a new farmer in Rulindo. She was advised by the Rwandan Agricultural Board take several samples of her soil and have it analysed. Imogene walks outside with a hand shovel and three plastic cups. In one cup, she takes a scoop of topsoil off the surface by her goat shelter. In the second cup, she takes another sample from the middle of her crop field. Her last sample is taken right outside of her door by her wash basin.

   a. What errors did Imogene make in collecting her soil samples?

   b. Which method did she use for collecting soil samples? How do you know?

   c. Provide Imogene with one piece of advice for next time.

   Answers:

   a. Imogene did not take her samples from the recommended depths, she did not use the proper tools for collecting her samples (auger, soil probe, soil sample box/kit), and she collected soil from near her animal shelter and her wash basin, which would contaminate the samples because of the animal waste and soaps and detergents in the ground from the shelter and wash basin area.

   b. The method she used was random sampling because she went to different locations not based on a grid or a certain benchmark. However, she did not do this method correctly because she took samples from unusual areas – near the wash basin and animal shelter.

   c. Try to obtain proper sampling tools, always sample from the proper depths and not right off the surface (0 to 15 cm, 15 to 30 cm, 30 to 60 cm), and avoid unusual areas as noted in **1.5 Key Facts**.

5. Move around to each group and help facilitate discussions by asking guiding questions. For example, “Even though she made a lot of mistakes, what method was Imogene close to following?”

6. When groups are finished discussing and recording their answers, ask a member from each group to share their answers. Encourage other trainees to ask questions and provide feedback on the shared answers.

Application Activity

1. Tell trainees that the school, in collaboration with the farmers in the surrounding area, wants to test the soil in a nearby field in order to begin cultivating soon. Direct trainees to **Topic 1.4 Task 4** in their manuals for this activity.

2. Bring trainees to a nearby field outside of the school. Divide them into groups of five and provide them with the tools and equipment needed to collect soil samples from the field.

3. Ask them to choose a sampling method (random or benchmark) and justify why they chose that method. (If they choose the benchmark method, they must say how they are going to following up – this method must compare data to a benchmark sample taken every year from a representative area of the land).

4. Tell trainees to have the process and guidelines from **1.5 Key Facts** on hand to refer to in their manuals. As they are practicing collecting samples, walk around and ask group members to explain to you and one another what part of the process they are doing.

5. At the end of the activity, bring everyone together and have someone from each group share their methods and any challenges they encountered during the activity.

Points to Remember

- **Proper depths for collecting soil samples:**
  - 0 to 15 cm
  - 15 to 30 cm
  - 30 to 60 cm

Formative Assessment

Explain to the trainees that the following assessment is to be done individually:

1. Why should you avoid taking samples from areas such as lime piles, fertilizer spills, ant hills, gate areas, livestock congregation areas, poorly drained areas, dead furrows, fertilizer bands, old fence rows, or any other unusual areas?

2. What is one way that soil loses its' fertility overtime?

3. Answer by identifying each statement as either **true** or **false:**
   a. The first sample should be taken from the surface of the soil.
   b. When a field has different types of soil or topography, more benchmark locations may be needed for sampling.
   c. Random sampling is not suitable for uniform fields.
4. What is a soil core?

5. Circle the correct answer.
   Before collecting a soil sample you should:
   a. apply fertilizer
   b. compact the soil
   c. plant crops
   d. none of the above

   Answers:
   1. Refer to **1.5 Key Facts** - Soil Sampling Procedure
   2. Refer to **1.5 Key Facts** - Soil Fertility
   3. a. False
      b. True
      c. False
   4. Refer to **1.5 Key Facts** - Soil Sampling
   5. D

ⓘ Further Information for the Trainer

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3. Soil Sampling and Soil Testing. (2015). *Grain News*. Retrieved from https://www.grainews.ca/2015/10/06/soil-sampling-and-soil-testing/?utm_source=FBC Publications&utm_campaign=a7441e9701-Grainews daily enews Oct 07, 2015&utm_medium=email&utm_term=0_2da8244677-a7441e9701-88089737
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Learning Outcome 1.5: Handle soil samples

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

a. Handle moist soil sample following the requirements.

b. Explain soil shipping requirements.

c. Describe moist soil sample handling procedures.

Time Required: 2 hours

Learning Methodology: Small group discussion, large group discussion (using scenarios, illustrations, and questions and answers), brainstorming, oral presentation of individual/group work, matching activities, and error analysis of real-world scenarios

Materials Needed:

- **Standard training materials -** notebooks, pen, whiteboard/black board, markers, flipchart
- **Visual materials** - internet for images and extra information needed, reference book for images,
- **Learning materials** - two paper signs that read “AGREE” & “DISAGREE,” three paper signs that read “HANDLING,” “DRYING,” & “SHIPPING,” small cards with key facts (enough for each student to have one card) written on them from each of the three sections of **1.6 Key Facts** (Handling, Drying, and Shipping)

Preparation:

- ❑ Obtain and prepare all materials and activities in advance including signs and fact cards for Tasks 1 and 2.
- ❑ Review and prepare scenarios and questions in advance**.**

Cross Cutting Issues:

- ✓ **Gender and inclusivity:** Consider gender balance while forming groups and allocating roles.
- ✓ **Standardization culture:** Encourage trainees to learn and apply the agreed upon standards and best practices in the handling and transporting soil samples.

Prerequisites:

- Basic measurements: temperature, humidity, etc.

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe moist soil sample handling procedures	**1.** Handle moist soil samples.	**1.** Analytical
2. List soil packaging requirements	**2.** Pack soil samples	**2.** Careful
3. Explain soil shipping requirements	**3.** Ship/transport soil samples	**3.** Team spirit

Steps:

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

1. Put a sign on one side of room that says “AGREE.” On the other side, place a sign that says “DISAGREE.” Tell participants this learning outcome is going to be on handling and preparing soils samples for transporting.

2. Explain that you will give them several statements related to the topic, which can also be found in **Topic 1.5 Task 1** in their manuals. If they agree, they should move to the sign that says “AGREE.” If they disagree, they should stand by the sign that reads “DISAGREE.”

3. After each statement, ask some trainees to explain to the class why they chose to either agree or disagree with that statement.

a. Soil samples should be sent to a laboratory within four hours of collecting it.

b. If a soil cannot be sent to the lab within 48 hours, dry the soil in an oven at a high temperature to kill any microbes.

c. Labelling the box or bag of the soil sample is part of the process.

Answers:

a. False/Disagree

b. False/Disagree

c. True/Agree

4. Explain to the trainees that they will discover the answer to these questions throughout this learning outcome.

5. Introduce the learning outcome and the direct them to the Key Competencies table in their Trainee Manuals.

Problem Solving Activity

1. Put three signs in different areas of the classroom: Handling, Drying, and Shipping.

2. Ask trainees to form small groups of five people. Give each group a set of five cards with facts written on them from each of the three sections of **1.6 Key Facts** (Handling Moist Soil Samples, Drying Soil Samples, and Shipping Soil Samples).

3. Direct trainees to **Topic 1.5 Task 2** in their manuals. Give each group member a card that has a key fact written on it. The card corresponds to one of the three main categories on the signs around the room. Explain to trainees that their task is to put each card under the appropriate category.

a. For example, with Drying Soil Sample, you would have a card that says, "Allow the sample to completely air dry at a temperature no more than 30°C."

4. Ask groups to first spend five minutes in their groups sharing, reading, and discussing their fact cards to determine the category they belong to.

5. Then, tell the groups to walk around the room placing their cards where they think they should go. Once their cards are placed, they should stand near them in that area of the room.

6. When everyone has placed their cards in the right place, ask individual trainees to explain why they placed that fact with that category.

7. Answer any questions and clarify information as needed.

8. Inform the trainees that after the class discusses **1.6 Key Facts**, they will have a chance to revise their knowledge from this activity.

Sample Cards:

Category Sign: Fact card to match with the category:

Handling soil samples	**Refrigerating or freezing the samples stops microbial activity.**

Guided Practice Activity

1. Before the next activity, divide the class into three groups. Assign each group a section of **1.6 Key Facts** to read aloud (handling, drying, or shipping).

2. After each section, pause to ask clarifying questions and make sure the trainees understand the terminology used.

3. Direct each group to walk around the room and check that the appropriate fact cards are with the correct category signs from **Topic 1.5 Task 2**. Encourage them to use the information provided to them in **1.6 Key Facts** in their Trainee Manuals to verify their answers.

4. At the same time, move around and help where needed.

5. After five to ten minutes of the trainees revising their knowledge from the last task, ask someone from the **handling** group to read a key fact card placed there. Then, ask someone from the **shipping** group to read a key fact from the shipping category. Repeat this for once more for the **drying** category and verify that all cards are placed in the correct category.

6. Now ask the trainees to get back into group of three people and present **Topic 1.5 Task 3:**

   Egide is a farmer in Huye. He is collecting soil samples to send for analysis. He properly collected a moist soil sample on Monday using the benchmark method of collection and stored it on a table inside of his home. On Thursday, he sent his sample to Kigali for analysis. Before he sent it, he labelled each container with the information specified by

the testing facility including the date of sampling, field number, contact name and sample depth.

a. What mistakes did Egide make?

b. What did Egide do correctly?

c. What advice can you offer Egide about this process for next time?

Answers:

a. Egide did not send his sample on the day it was collected. Instead, he sent it on Thursday. This would have been ok if he had refrigerated it, but he left the sample on his table in his home. This is not acceptable.
b. Egide properly labelled all of his samples for shipping/transporting.
c. If you do not have refrigeration, send the sample for analysis on the day it is collected.

7. Provide each group with time to analyse the scenario using the information provided to them in **1.6 Key Facts**. Move from one group to the next, helping them analyse the scenario and discuss the questions.

8. When the trainees are finished with the task, ask a few groups to share their responses. Encourage other trainees to ask questions and provide feedback as they listen.

Application Activity

1. Tell the trainees that for this activity, they will work with a partner sitting next to them.

2. Ask trainees to analyse some packed soil samples before transportation using the information from **Topic 1.5 Task 4** in their manuals:

Sample 1:

- Collected more than two days ago
- Not refrigerated
- Dried in oven
- Carton is labelled with the date, contact, location, depth of soil

Sample 2:

- Collected three days ago
- Dried in room at 35 degrees Celsius
- Carton contains residue from a previous soil sample
- Carton is labelled with the date

3. For each sample ask the trainees to answer the following questions:

a. Are the soil samples ready for transporting? Why or why not?

Possible Answers:
Sample 1 is not ready: It should have been either refrigerated or dried properly in the air, not in the oven. The carton is well labelled.
Sample 2 is not ready: The room temperature was too hot. It should be 30 degrees Celsius. The carton is contaminated from a previous sample. Also, the labelling is not complete. It needs the contact, location, and soil depth.

b. Explain to the sample collector why it is essential for him/her to carefully and correctly follow each step of the soil collecting and handling process.

4. At the end of the activity, ask pairs of trainees to share their answers with the class and encourage others to provide observations and feedback.

Points to Remember

- To dry samples prior to shipping, spread out each soil sample on a clean surface and allow the sample to completely air dry at a temperature no more than 30°C. Do not dry in an oven, microwave, or at a high temperature.
- When shipping samples, be sure to fill the soil sample bags or cartons with 0.5 kg of soil and label each container with the information specified by the testing facility including the date, soil depth, contact and location.
- Remember to note in detail where unusual problems exist.
- Ensure that samples do not become contaminated with anything that might invalidate test results (e.g., fertilizer).

Formative Assessment

Explain to the trainees that the following assessment is to be done individually:

1. Answer by identifying each statement as either **true** or **false:**
   a. Soil samples should always be accompanied by information about the site, cropping expectations, and management.

   b. Moist samples should not spend more than two days in transit.

   c. Crop rotation does not have an effect on soil nutrients.

2. Why shouldn't you dry soil samples in an oven or a microwave?

3. Explain what the freezing or refrigeration process does to a soil sample.

4. Complete the following sentences:
   a. Fill the soil sample bags or cartons with _____ of soil.

   b. Proper handling of soil samples before analysis will _____.

Answers:

1. a. True
   b. True
   c. False

2. This can change the levels of some nutrients, invalidating test results, and fertilizer recommendations.

3. Refrigerating or freezing the samples stops microbial activity.

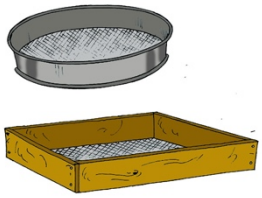
4. a. 0.5 kg.
   b. help ensure reliable test results

Self-Reflection

1. Ask the trainees to re-take the self-assessment they took at the beginning of the unit. They should then fill in the table in the Trainee Manual to identify their areas of strength, areas for improvement and actions to take to improve.

2. Discuss trainees' results with them. Identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Learning Unit 2: Assist in preparing soil samples for laboratory testing




LABORATORY

Learning Outcomes

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

2.1 Select laboratory soil protocols and procedures

2.2 Prepare soil samples

2.3 Apply laboratory analyser recommendations

Learning Unit 2 Self-Assessment

1. Ask trainees to look at the illustration above (in their Trainee Manuals) and discuss what they see. What topics do they think this unit will include based on the picture? After some brainstorming, share the main topics.

2. Explain that this Learning Unit is going to focus on preparing soil samples for laboratory testing, including how to follow the laboratory protocols and procedures, prepare the soil samples, and apply recommendations.

3. Ask trainees to fill out the self-assessment at the beginning of the unit in their Trainee Manuals. Explain that the purpose of the self-assessment is to become familiar with the topics in the unit and for them to see what they know or do not know at the beginning. At the end of the unit, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas that need improvement and actions to take. The self-assessment is not a test!

Learning Outcome 2.1: Select laboratory soil protocols and procedures

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

a. Identify soil sample preparation procedures
b. Follow soil sample preparation protocol
c. Follow soil sample preparation procedures

Time Required: 4 hours

Learning Methodologies: large and small group discussions/brainstorming, group work, individual work, multimedia listening comprehension, peer-to-peer learning review, practical application/field work

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper
- **Soil laboratory testing tools** - blades, tubes, auger, hoe, forked hoe, shovel, machete, container, hook, spade, shovel, saws, motor, sieve, weight device/scale, sheeting, sacks, plastic bags and net bags, tape-measurer, clipboards for writing in the field, gloves (PPE).
- **Visual/audio equipment -** Internet, computer, projector for viewing, speakers for listening activity (video), reference book for any additional information

Preparation:

- ❑ Obtain and prepare soil sampling tools and equipment.
- ❑ Reserve and prepare a field nearby the school in advance for practice soil sampling.
- ❑ Download and preview video for listening comprehension: https://www.youtube.com/watch?v=--fdaGmYwEw (Search YouTube: Sample Soiling Guidelines).

Cross Cutting Issues:

- ✓ **Gender and inclusivity:** Consider gender balance while forming groups and allocating roles.
- ✓ **Standardization culture**: Solidify trainees' understanding of proper protocol and procedures/standards as they pertain to soil sampling.

Prerequisites:

- Learning Outcome 1.5: Handle soil samples

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain soil sample preparation protocols	**1.** Select soil sample preparation procedures	**1.** Team spirit
2. State soil sample preparation procedures	**2.** Follow soil laboratory protocols	**2.** Analytical
3. Explain soil sample preparation practices	**3.** Follow soil sample preparation protocol	**3.** Honest

Steps:

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

1. Facilitate a class discussion to begin the unit. Ask trainees to give examples of when they have had to follow a protocol or procedure (specific rules and steps to a process).

2. Next, ask trainees to define the following terms:

a. Protocol

b. Procedure

3. Introduce the learning outcome and the types of knowledge, skills and attitude they will acquire after learning.

Answers to Question 2:

a. Protocol: a set of guidelines specifying a procedure that must be followed if an agency is to accept the results.

b. Procedure: a set of written directions telling us how to apply a method to a particular sample, including information on obtaining samples, handling interferents, and validating results.

Problem Solving Activity

1. Ask trainees to form groups of five people.

2. Tell trainees to read the following instructions and questions from **Topic 2.1 Task 1:**

   Based on what you learned from Unit 1, what are some of the essential ways to collect and prepare soil samples for transport before you send them to a laboratory? Make a list of facts that will help the class review together.

   Answers: See **1.5 and 1.6 Key Facts** from Learning Unit 1.

3. Inform trainees that their group must try to brainstorm at least five things to review from Learning Unit 1 that relates to this topic.

4. Walk around the room and help facilitate group discussions.
   a. For example, "What do you remember about refrigerating or freezing samples?" "Do you remember how to label bags when sending a sample for transport?"

5. Ask groups to provide what they discussed and wrote down. As the groups provide responses from **1.5 and 1.6 Key Facts**, write them on the board/flipchart for the class to see.

6. Explain to the class that this topic will build on what they learned in Unit 1.

Guided Practice Activity

1. Before the next activity, read through **2.1 Key Facts** with the class, pausing after each one to ask clarifying questions and make sure the trainees understand the terminology used.
   a. Sample clarification questions: "Do we remember the tools and equipment to use for soil sampling? What are they?"

2. Now divide the trainees into groups of four and show them the following video that presents a farmer demonstrating some of the procedures and best practices of soil sampling:
   a. https://www.youtube.com/watch?v=--fdaGmYwEw (Search YouTube: Soil Sample Guidelines)

Note: If you do not have access to the internet, demonstrate the best practices of soil sampling for the trainees.

3. Explain that you will show them the video three times. For the first time, tell them to just watch and listen (no writing). On the second viewing, tell the trainees to watch and listen to answer the questions below, from **Topic 2.1 Task 3**. The third viewing will be a chance for the trainees to get any other information that they missed.

4. Provide time to the groups to answer the following questions from **Topic 2.1 Task 3:**

a. According to the Soil Sampling Guidelines video, what is the first thing you need to decide before sampling?

b. How many soil cores does the farmer in the Soil Sampling Guidelines video recommend taking?

c. What are two essential pieces of information that were not in the video?

d. What the most important piece of information presented in the video? Explain why.

5. As the groups are working, move around to facilitate discussions and ensure that they listen to the video and refer to **2.1 Key Facts**.

6. Ask each group member to present an answer to one of the four questions from the task. As they present, encourage others to ask questions and give feedback.

Answers to Question 4:

a. Are you going to sample the whole field or are you going to divide the field up into different soil types? What method are you going to use?
b. 10-15 soil cores. 5-8 cores for grid sampling.
c. Refer to any other information from **2.1 Key Facts.**
d. Answers will depend on group discussions. They should relate or come from **2.1 Key Facts.**

Application Activity

1. Bring the trainees to a nearby field to practice collecting soil samples and provide each group with the proper tools and materials.

2. Divide the trainees into groups of 4-5 people.

3. Ask trainees to prepare soil samples using the information provided in **2.1 Key Facts.** Explain that you will walk around and observe them as they collect samples. Note that you expect them to be able to explain the process as they conduct it.

   Note: You could demonstrate to the class how to collect soil samples first if they are not able to do it easily.

4. Tell the trainees that they will now collect samples as practice using the information from **2.1 Key Facts** - **sampling procedures** and **shipping samples.**

5. After collecting their samples, tell trainees to prepare and demonstrate the process as detailed in the **shipping samples** section of **2.1 Key Facts**.

6. At the end of the activity, bring everyone together and ask each group to present the information they wrote on their bags, according to proper procedures.

7. Provide your observations and feedback.

Points to Remember

- The content of the protocol specifies the guidelines of a procedure/method.

Formative Assessment

Explain to the trainees that the following assessment is to be done individually.

1. Identify each statement as either **true** or **false**:
   a. When taking a soil sample, you should avoid taking samples from areas such as lime piles, fertilizer spills, ant hills, poorly drained areas, fertilizer bands, or any other unusual areas.

   b. Soil samples do not always have to be accompanied by information about the site, cropping expectations and management.

   c. Label the sample bag carefully with your company name, farm name, field name, sample depth and date, and crop to be grown.

   d. Wet soil gives the most accurate reading/results.

2. What is the difference between procedure and protocol?

3. When is it NOT recommended to take a sample?

4. Give an example of an interferent in a soil sample and explain why it is considered an interferent.

Answers:

1. a. True
   b. False
   c. True
   d. True

2. Protocol are the guidelines to follow in the procedure. Protocol is the rule/guidelines, while procedure is the method/process.

3. Do not take samples immediately after heavy rainfall or irrigation events, or after applications of manure or compost.

4. An interferent is any substance whose presence interferes with an analytical procedure and generates incorrect results. Manure and fertilizers can be interferents.

Further Information for the Trainer

1. Sampling Procedures. (n.d.). Retrieved December 9, 2019, from https://www.wardlab.com/sampling-procedures/.
2. Soil Sampling Guidelines. (2011, August 22). Retrieved December 9, 2019, from https://www.youtube.com/watch?v=--fdaGmYwEw.
3. Soil Sampling Protocol for Soil Organic Matter Analysis. (n.d.). Retrieved December 9, 2019, from https://www.cdfa.ca.gov/oefi/healthysoils/docs/HSP_SoilSampling.pdf.
4. http://extensionpublications.unl.edu/assets/pdf/g1740.pdf
5. http://www.css.cornell.edu/extension/soil-health/sampling.pdf

Learning Outcome 2.2: Prepare soil samples

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

a. Follow soil sample drying/crushing /mortaring weighing/sieving guidelines

b. Dry/crush/mortar/weigh/sieve soil samples

c. Explain soil sample packing requirements

Time Required: 4 hours

Learning Methodology: Small and large group discussions, individual work, multimedia listening comprehension, peer-to-peer learning/brainstorming, practical application, class review

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper
- **Soil sampling tools -** sieves, weighing devices, soil samples drying on racks in advance, plastic or paper bags, hammers and/or rolling pins for crushing, gloves (PPE)
- **Audio/visual equipment -** Internet for reference, computer, reference book, downloaded videos from YouTube, projector, speakers
  1. https://www.youtube.com/watch?v=Al1v-jARhLM (Search YouTube: Soil Sample Preparation)
  2. https://www.youtube.com/watch?v=jQTOCfFbDUQ (Search YouTube: Soil Sample Processing: Sieving)

Preparation:

- ❑ Obtain and prepare all materials and activities in advance. Place the dried soil samples on drying trays for the trainees to practice with (if possible, use soil samples collected from Topic 2.2 Task 4).
- ❑ Prepare all soil preparation equipment in advance.
- ❑ Download and preview YouTube tutorials on soil sample preparation.

Cross Cutting Issues:

- ✓ **Gender and inclusivity:** Consider gender balance while forming groups.
- ✓ **Standardization culture:** Trainees will learn and practice proper procedure and protocol as well as best practices in soil sampling.

Prerequisites:

- ▸ Basic knowledge of soil sample preparation
- ▸ Basic knowledge of tools and equipment used in soil sampling

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain soil sample drying guidelines	**1.** Dry moist samples	**1.** Team spirit
2. Explain soil sample preparation guidelines	**2.** Sieve soil samples	**2.** Analytical
3. Explain soil sample packing requirements	**3.** Pack soil samples	**3.** Accurate

Steps:

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

1. Facilitate a group discussion and review by referring to **Topic 2.2 Task 1.** Tell trainees to look at pictures A, B, and C in their manuals and identify the items and actions with a partner. Tell trainees to use what they already know about soil sampling to make their predictions.

2. Allow the trainees to make educated guesses regarding the pictures and write their ideas on the board/flipchart. Then, verify their answers.

3. Direct the trainees to the Key Competencies table in their Trainee Manuals and introduce the topic of the lesson: Preparing soil samples. Explain to the trainees that this learning outcome will build on content they learned in Unit 1.

Answers:

A. Sieve – sieving (filtering) the soil.
B. Drying areas – Drying the soil samples.
C. A weighing device/scale – weighing the soil samples.

Problem Solving Activity

1. Now that the trainees know the correct items and actions from the pictures in **Topic 2.2 Task 1**, ask trainees to form groups of five people and answer the questions from **Topic 2.2 Task 2:**
   a. Why do you think it is important to sieve/filter a soil sample?

   b. What purpose of drying have in preparing a soil sample?

   c. Why do you need to weigh the soil sample when preparing it?

   d. Why do you think it is important to mortar/crush/grind a soil sample?

   e. Why do you think it is important to mortar/crush/grind a soil sample?

2. Ensure that each group member has one question to answer. Tell the groups to discuss these questions and use the knowledge they have previously learned to help them.

3. Move around the room, providing your input to each group as needed.

4. Ask each group to present their answers.

5. Offer your observations and feedback.

6. Inform the group that they will return to this activity to revise their answers after discussing **2.2 Key Facts**.

Guided Practice Activity

1. Before the next activity, read through each section of **2.2 Key Facts**, pausing after each one to ask questions and make sure the trainees understand the terminology used.

2. Next, ask the trainees to go back to **Task 2** to revise their answers from **Question 1**. Ask for 3 to 5 volunteers to properly answer the questions again using the information provided in **2.2 Key Facts**.

3. To enhance their understanding of **2.2 Key Facts**, show the following videos to the trainees. Show the videos more than once, if necessary:

a. https://www.youtube.com/watch?v=Al1v-jARhLM (Search YouTube: Soil Sample Preparation)

b. https://www.youtube.com/watch?v=jQTOCfFbDUQ (Search YouTube: Soil Sample Processing: Sieving)

4. Now, read **Topic 2.2 Task 3** to the trainees and divide them into groups of four people.

   Your school wants to provide a training on how to prepare soil samples. Your class has been asked to prepare training materials that must include illustrations and explanations of each process detailed in **2.2 Key Facts.**

5. Assign each group member one of the sections of **2.2 Key Facts**. They must create an illustration of the process and write an explanation of it in their own words. They must not copy the exact words from **2.2 Key Facts**.

6. During the activity, move around and help each trainee understand and explain the processes.

7. When the trainees are finished, ask the groups to present their materials to help train others at their school. Encourage them to ask questions and provide feedback to each other.

8. Provide your input and feedback.

Application Activity

If possible, use the soil samples that were collected from Learning Outcome 2.1 for this activity. If you do not have them, then you will need to collect more soil from outside of the classroom.

1. Divide the trainees into groups of four people and provide each group with the necessary items to prepare the soil samples: collected soil on drying trays, sieves, weighing devices, hammer/crushing device, bags for packaging.

2. Read **Topic 2.2 Task 4** to the groups:

With your group, practice crushing, sieving, weighing, and packaging soils samples that have already been dried. Be prepared to demonstrate this process to your trainer as well as the class. Explain that for this practice application, they will not have time to properly dry the soils.

3. As students practice the preparation process with the dried soil samples, move around the room to offer your advice and assistance as needed.

4. At the end of the activity, ask volunteers to demonstrate certain parts of the process (weighing, sieving, crushing, etc.) to the class.

Points to Remember

- If samples cannot be sent to the laboratory immediately, they can be air dried at a temperature no more than 30°C.
- Always label soil samples before shipping.

Formative Assessment

Explain to the trainees that the following assessment is to be done individually:

1. Identify the following statements as either **true** or **false**:
   a. Soil samples should be dried in direct sunlight until constant mass has been achieved.

   b. The drying temperatures above 65 ° C can activate carbon oxidation.

   c. All soil samples must be dried together to achieve good results

2. What is the purpose of mortaring?

3. What is a sieve and what role does it have in soil sample preparation?

Answers:

1. a. False
   b. True
   c. False
2. Mortaring helps keep the soil uniform and facilitates the process of sieving.
3. A sieve is a wire or plastic mesh held in a frame, used for straining solids from liquids, for separating coarser from finer particles, or for reducing soft solids to a pulp. Sieving is a practice or procedure used to assess the size of the particles (or gradation).

ⓘ Further Information for the Trainer

1. (n.d.). Retrieved December 9, 2019, from http://www.cglrc.cgiar.org/iita/soilSampling/.
2. Soil Sample Preparation. (2014, April 4). Retrieved December 9, 2019, from https://www.youtube.com/watch?v=Al1v-jARhLM.
3. Soil Sample Preparation. (2019, August 7). Retrieved December 9, 2019, from https://www.aweimagazine.com/article/soil-sample-preparation-97/.
4. Soil Sample Processing: Sieving. (2013, July 31). Retrieved December 9, 2019, from https://www.youtube.com/watch?v=jQTOCfFbDUQ.
4. Öhlinger, R. (1996, January 1). Soil Sampling and Sample Preparation. Retrieved December 9, 2019, from https://link.springer.com/chapter/10.1007/978-3-642-60966-4_2.

Learning Outcome 2.3: Apply laboratory analyser recommendations

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

a. Interpret the information in a soil analysis report.

b. State a normal range of soil parameters.

c. Follow guidelines in soil analyser recommendations.

Time Required: 2 hours

Learning Methodology: Large group discussion, scenario-based discussion and brainstorming in pairs, real-world application through hypothetical scenarios

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, pens
- **Research resources –** internet, computers for reference, reference books

Preparation:

- ❑ Preview and prepare all tasks and materials in advance.
- ❑ Prepare formative assessment in advance.

Cross Cutting Issues:

- ✓ **Gender and inclusivity:** Consider gender balance when forming groups.
- ✓ **Standardization culture:** Learn and practice proper procedure and protocol as well as best practices in applying recommendations from soil analysis reports.

Prerequisites:

- ▸ Collecting and preparing soil samples

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain Information in a soil analysis report	**1.** Interpret a soil analysis report	**1.** Analytical
2. State normal range of soil analysis parameters	**2.** Apply soil analysis recommendations	**2.** Teamwork spirit
3. Explain guidelines in soil analysis recommendations	**3.** Apply laboratory analyser recommendations	**3.** Careful

Steps:

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

1. Direct trainees to **Topic 2.3 Task 1** in their manuals. Tell them to turn and talk with a partner about the following terminology. Based on what they have learned about collecting and preparing soil samples, what do they think these terms mean and how do they relate to soil analysis?

- pH
- Acidity
- Nutrients
- Lime
- Fertilizer

2. After the trainees have discussed with their partners, facilitate a class discussion about the terms.

3. Write the trainee's ideas on the board/flipchart.

4. Introduce the topic and direct the trainees to the Key Competencies table. Inform them that in this learning topic, they will learn how to apply recommendations from soil analysis.

Problem Solving Activity

1. Inform the trainees that for this activity, they will work with the person sitting next to them**.** Direct them to **Topic 2.3 Task 2** in their manuals.

2. Read the scenario to the trainees and tell them to discuss the questions that follow with their partner:

   Fabrice is a new farmer in Nyamata. He carefully followed the soil collection and preparation processes in order to send his soil samples to a lab for analysis. However, he does not know what information the lab will tell him about his soil or what he will need to do about the report they will give him. Fabrice knows you are studying growing mediums and soil analysis, so he asks you to help him understand the following:

   a. Based on your education so far, what information do you think is included in a soil analysis report?

   b. What advice do you have for Fabrice when he receives his lab report?

3. As the trainees are working on this task, move around the room to help facilitate discussions on the questions.

4. When the pairs are finished, have each group present their answers and facilitate a class discussion. Encourage the other trainees to ask questions and provide feedback based on the answers being presented. Use the information in **2.3 Key Facts** to give trainees feedback.

Guided Practice Activity

1. First, read through **2.3 Key Facts** with the class, pausing after each one to ask questions and make sure the trainees understand the terminology used.

2. Direct trainees to **Topic 2.3 Task 3**. Read them the following information and tell them to complete the tasks with their partner:

   a. State the key information provided in a soil analysis report.

b. The school laboratory analysis results show that the soil pH is 3.5 and the N-P-K concentration is 12-7- 0.

i. What do these results mean?

ii. What are your suggestions to meet the crop requirements if the crop to be planted requires soil pH 5.5 and the N-P-K concentration is 20-20-10?

3. As trainees are working on the tasks, move around the room to help as needed and ask guiding questions.

a. For example: *"Why do you think that is?"*

4. When the trainees have finished working, randomly ask trainees to stand up and present their answers using evidence from **2.3 Key Facts** to support their answers.

5. Provide observations and feedback as needed.

Answers to Question 2:

a. Client information, sample identification, date sample was received and processed, nutrient analyses, soil quality parameters (e.g., pH, organic matter, EC), and fertilizer recommendations

b. **i.** These results mean the soil is acidic the Nitrogen is at 12%, Phosphorus is at 7% and the Potassium is at 0%.

ii. The soil is acidic and to meet the crop requirement the soil pH should be raised from 3.5 to 5.5 by applying lime. The NPK content of the soil is below the crop requirement that mean the NPK value should be raised from 12-7-0 to 20-20-10 NPK respectively to avoid crop nutrient deficit.

Application Activity

1. Inform the trainees that for this activity, they will again work with the person sitting next to them.

2. Refer trainees to **Topic 2.3 Task 4** in their manuals and read the soil analysis report together as a class:

Rwandan Agricultural Board. Soil Analysis – 12, December 2019.

I. Client: NSABIMANA, Jean Claude. 0782.999.000. JClaude@gmail.com. Northern Province, Rulindo District.

II. Sample Information: Soil sample from prospective farm in Tumba, Rulindo.

III. Received: December 11, 2019 at 1500h.
Processed: December 12, 2019 at 0800h.

IV. Nutrient analysis & recommendations:
   a. N = 20%; Recommended = 10%
   b. P = 5%; Recommended = 20%
   c. K = 2%; Recommended = 20%

V. Soil quality parameters:
   a. pH = 4.0; Recommended = 7.0
   b. Organic matter content = 2%; Recommended = 3-6%

3. Instruct trainees to analyse the report and give fertilizer recommendations to Jean Claude according to the report.

4. As the trainees are discussing the hypothetical analysis report with one another, move around the room to help and feedback as needed.

5. At the end of the activity, ask trainees to read their recommendations to the farmer. Encourage others to listen carefully and offer feedback to the trainees presenting the information.

Answer to Question 3:
Fertilizer recommendations: NSABIMANA Jean Claude should apply phosphorus and potassium fertilizers. His soil also needs to be less acidic, so he should apply lime. Jean Claude also needs to apply organize matter such as compost in order to increase the organic matter content of his soil.

Points to Remember

- The normal range of each nutrient analysed should be taken into consideration when applying soil analyser recommendations.

Formative Assessment

Inform the trainees that the following assessment is to be done individually:

1. Explain how to determine how much lime to apply to soil.

2. What do N, P, and K mean?

3. What is the difference between an N-based fertilizer and a compound fertilizer?

4. Identify each statement as either **true** or **false:**

a. The world's most widely used fertilizer is Nitrogen.

b. A high pH means your soil is acidic.

c. Lime should be applied every year.

Answers:

1. Lime application is determined by the analysis provided.

2. N is nitrogen. P is phosphorus, and K is potassium.

3. N-based fertilizer is just nitrogen whereas a compound fertilizer is a combination of different nutrients.

4. **a.** True
b. False
c. False

Self-Reflection

1. Ask trainees to re-take the self-assessment at the beginning of the unit. They should then fill in the table in the Trainee Manual to identify their areas of strength, areas for improvement and actions to take to improve.

2. Discuss trainees' results with them. Identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Further Information for the Trainer

1. NSW Department of Primary Industries. (2017, August 16). Retrieved December 10, 2019, from https://www.dpi.nsw.gov.au/.
2. Sustainable Agriculture. (n.d.). Retrieved December 10, 2019, from https://iaa.umd.edu/areas-study/sustainable-agriculture.

Learning Unit 3: Perform tillage for planting

Learning Outcomes

By the end of this learning unit, trainees will be able to:

3.1 Select land for tillage according to soil structure and vegetation

3.2 Identify tools and equipment for tillage according to the land conditions

3.3 Identify tillage types according the crop requirements

3.4 Perform tillage according to the soil structure

Learning Unit 3 Self Assessment

1. Ask trainees to look at the illustration above (in their Trainee Manuals) and discuss what they see. What topics do they think this unit will include based on the illustrations? After some brainstorming, share the main topics.

2. Explain that this Learning Unit will focus on tillage operations, defined as mechanical manipulation of soil, which are performed to provide the optimum environment for seed germination and plant growth. Seedbed preparation for sowing and planting of different crops is done through primary and secondary tillage operations.

3. Ask trainees to fill out the self-assessment at the beginning of the unit in their Trainee Manuals. Explain that the purpose of the self-assessment is to become familiar with the topics in the unit and for them to see what they know or do not know at the beginning. At the end of the unit, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas that need improvement and actions to take. The self-assessment is not a test!

Learning Outcome 3.1: Select land for tillage

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

a. List the criteria for selecting the land site

b. Choose the land site for tillage

c. Explain the criteria for choosing the land for tillage

Time Required: 5 hours

Learning methodologies: Large and small group discussions, brainstorming, peer-to-peer teamwork and learning, real-world scenario-based problem-solving activities and questions, practical application using multimedia

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, reference books
- **Online materials –** Internet, computer for reference, projector

Preparation:

- ❑ Preview and prepare all tasks and materials in advance.
- ❑ Review scenarios and tasks in advance.
- ❑ Prepare formative assessment in advance.

Cross Cutting Issues:

- ✓ **Gender and inclusivity:** Consider gender balance when forming groups.
- ✓ **Standardization culture:** Learn and practice proper procedure and protocol as well as best practices in selecting land for tillage.

Prerequisites:

- ▸ Basic knowledge of topography and soil

Key Competencies:

Knowledge	Skills	Attitudes
1. List the criteria for selecting the land site	**1.** Select land for tillage using criteria	**1.** Team spirit
2. Explain the criteria for choosing the land for tillage	**2.** Choose the land site for tillage	**2.** Analytical
3. Explain the characteristics of the land for tillage	**3.** Analyse the land characteristics	**3.** Accurate

Steps:

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

1. Facilitate a discussion by reading **Topic 3.1 Task 1** to the trainees:

Discuss your experience with tilling: the preparation of land for growing crops.

a. Where did you till or see tilling?

b. Why were you or another person preparing the land?

2. As trainees discuss the questions, ask them to call out their responses as you write them on the board for the class to see.

3. Introduce the learning outcome and the Key Competencies table with the knowledge, skills, and attitudes they will acquire after this learning outcome. Inform them that this topic will focus on how to select land for tillage according to soil structure and vegetation.

Problem Solving Activity

1. Ask trainees to form small groups of five people. Direct them to **Topic 3.1 Task 2** in their manuals.

2. Tell them to think about all the factors that go into having a successful farm. Instruct them to brainstorm with their groups and write a list of all the factors that affect the decision of where to put a farm.

3. Move around the room to help facilitate discussion among the groups. Provide your help as needed and ask guiding questions as you visit each group. For example, "Do you think that there needs to be a clean water source nearby?"

4. When the trainees are finished discussing, ask someone from each group to present their list of ideas. Encourage others to ask questions and provide feedback.

5. Explain to the trainees that after the class discusses **3.1 Key Facts**, they will go back to the list and revise their answers.

Guided Practice Activity

1. Read through **3.1 Key Facts** out loud with the class, pausing after each one to ask guiding questions and make sure the trainees understand the terminology used.

2. Ask trainees to go back to **Topic 3.1 Task 2** and revise the lists they made based on **3.1 Key Facts**. Ask a few volunteers to share what information they added to their lists and what they removed.

3. Explain that they will now work in pairs with the person sitting next to them. Read the scenario from **Topic 3.1 Task 2** in their manuals:

   Karori would like to select some of his land for tillage in the next dry season. He has two different plots with the following characteristics:

   Plot 1:

   - Soil is slightly acidic
   - Soil is 40 cm deep
   - Water holding capacity is low.
   - The water source is far away.

Plot 2:

- Slightly acidic soil
- Soil is 30 cm deep
- Water holding capacity is high

4. With their partners tell trainees to discuss which plot of land Karori should select for tillage and why.

5. Move around to each pair of trainees and facilitate discussion among them. Ask them which information from **3.1 Key Facts** they are referring to as evidence to support their answers.

6. When the trainees are finished discussing and writing their answers, call on trainees to present their answers and encourage all trainees to support their answers with evidence from **3.1 Key Facts**.

Answer to Question 4:

The second plot is to be selected because of its characteristics are better than the first one. Plot 1 had soil with low water holding capacity and that is far away from the water source.

Application Activity

1. Ask trainees to form groups of three people and turn to **Topic 3.1 Task 4** in their manuals.

2. Explain that each group must discuss and decide if each image is appropriate to be tilled. Then, the groups must prepare a brief presentation for the class explaining why the images are or are not good land for tillage. Encourage them to reference **3.1 Key Facts**.

3. During the activity, walk around and talk with groups, helping them as needed.

4. At the end of the activity, ask each group to present their reasons for or against tillage of each area pictured. Encourage other groups to challenge each other by asking questions and agreeing or disagreeing.

5. Provide your observations and feedback.

Points to Remember

- When selecting land for tillage, always consider the type of crop to be grown.

Formative Assessment

Explain to the trainees that the following assessment is to be done individually:

1. Identify the following statements as either **true** or **false:**
   a. Soil depth should be taken into consideration when selecting the field site.

   b. Availability of water should not be taken into consideration when selection the field site for tillage.

   c. Soil quality should be taken into consideration when selecting the field site for tillage.

2. What influence does soil depth have on site selection?

3. Explain why the sustainability of a water source of a piece of land is important.

Answers:

1. a. True
   b. False
   c. True

2. Depth affects the growth and distribution of the root systems of plants.

3. The sustainability of a water source is important because it directly relates to the success and longevity of a farmer's land.

Further Information for the Trainer

1. Klein, P., & Zaid Date, A. (n.d.). CHAPTER VI: LAND PREPARATION, PLANTING OPERATION AND FERTILISATION REQUIREMENTS. *Production Support Programme*. Retrieved from http://www.fao.org/3/y4360e/y4360e0a.htm

2. Suitable methods of tillage for the farm. (n.d.). Retrieved from http://www.fao.org/3/y5146e/y5146e08.htm

Learning Outcome 3.2: Identify tools and equipment for tillage

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

a. Explain selection criteria for tool and equipment for tillage

b. Choose tools and equipment for tillage

c. Explain the working condition of stools and equipment used for tillage

Time Required: 5 hours

Learning Methodology: Large group discussion, small group discussion, real-world scenario-based tasks, review and brainstorm using previously learned content, peer-to-peer tasks, hands-on demonstrations and inquiry

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper
- **Farm tools -** hoe, shovel, pick, rake, fork, machete, axe, hand tiller, manual plow
- **Learning materials –** Internet, computer for reference, reference books

Preparation:

- ❑ Obtain the tools and materials needed, if possible. If it is not possible, use images from the internet and/or reference books.
- ❑ Download and preview video in advance: https://www.youtube.com/watch?v=h0dObwn_H2w (YouTube search: 8 best hand tillers of 2016).
- ❑ Read and review scenarios and assessments in advance.

Cross Cutting Issues:

- ✓ **Gender and inclusivity:** Consider gender balance when forming groups.
- ✓ **Standardization culture:** Learn and practice proper procedure and protocol as well as best practices in identifying and selecting tools and equipment for tillage.
- ✓ **Financial education:** Emphasize the importance of buying locally sourced tools/equipment with spare parts available so repairs and maintenance can be economical.

Prerequisites:

- Basic knowledge of farm tools and equipment

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain the selection criteria for tools and equipment	**1.** Choose tools and equipment to use for tillage	**1.** Team spirit
2. Explain the working conditions of tools and equipment used for tillage	**2.** Determine the working condition of tools and equipment	**2.** Analytical
3. Explain the relationship between working conditions and the efficiency of tools and equipment	**3.** Determine the effectiveness of tools and equipment	**3.** Decisive

Steps:

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

1. Facilitate a class discussion based on the experience of the trainees and by asking the following questions from **Topic 3.2 Task 1**:

a. What types of tools are used for tilling the land?

b. How do you decide which tools to use for tilling?

2. As the class discusses their responses, ask trainees to share their thoughts and ideas. Write the answers on the board as you hear them.

3. Introduce the learning outcome and the types of knowledge, skills, and attitudes they will acquire by the end of this topic.

Problem Solving Activity

1. Present **Topic 3.2 Task 2** to the trainees and ask them to work with the person sitting next to them to identify each image and its purpose on a farm.

2. Move around the room to encourage and facilitate discussion among the partners.

3. Write letters A-G on the board and ask different trainees to come up and write the names and roles of one piece of equipment.

   Example:
   A. Rake
   Role: To spread organic matter over the soil

4. Explain that it is fine if the answers are not correct because the class will revisit these after a discussion of **3.2 Key Facts** to revise and edit their responses.

5. As volunteers are writing their answers, encourage the class to ask questions, offer feedback and challenge each (agree/disagree).

Answers to Question 1:

A. Rake
B. Pick
C. Turning fork
D. Shovel
E. Hoe
F. Old mouldboard plow
G. Auger

Guided Practice Activity

1. Read through all of **3.2 Key Facts** with the class, pausing after each one to ask clarifying questions and make sure the trainees understand the terminology used.
   a. As an extra resource, show the trainees the following video and ask which tools they see and/or are familiar with:
   https://www.youtube.com/watch?v=h0dObwn_H2w
   (YouTube search: 8 best hand tillers of 2016)

b. It is also helpful to have some tools on display in the classroom and to refer to them as they are mentioned by trainees and discussed in **3.2 Key Facts**. These tools need to be obtained and prepared in advance.

2. Direct the trainees to return to **Topic 3.2 Task 2** and revise their answers using the information from **3.2 Key Facts**.

3. Facilitate a brief discussion on the roles of each piece of equipment.

4. Now, trainees will work with a partner next to them. Ask the trainees to read the scenario from **Topic 3.2 Task 3** in their manuals and discuss the questions that follow:

Eric is in Kigali to purchase equipment for his farm in Rulindo. His plot of land is on the side of a mountain and has clay soil that is very compacted.

a. What tools and equipment do you recommend he look at?

b. Give Eric some advice before he purchases equipment in Kigali.

5. As the partners are working on **Topic 3.2 Task 3** and discussing their answers, move around the room to help them as needed.

6. Ask volunteers to stand up and present their answers to **Question 4** in **Topic 3.2 Task 3**.

7. Offer feedback as needed.

Possible Answers to Question 4:
Since Eric is farming on the side of a mountain, pulling ploughs with a tractor is likely not possible so he should look for hand tools. Eric would benefit from a pick, a hand tiller, and/or a raked hoe for breaking up the soil. He is fortunate to have clay soils because they are rich in nutrients if they can be properly broken up.

Application Activity

1. Direct the trainees to read **Topic 3.2 Task 4** and complete the tasks individually:

A farmer next to the school needs guidance on how to select the appropriate tools and equipment to till his land. The farmer's land is flat and made up of clay soil. Right now, he wants to only grow potatoes and it is in the rainy season. The farmer has a lot of money to spend on his farm. As a technician in training, you have been requested to advise him on which tools to use based on the selection criteria of tools and equipment.

a. Prepare a brief presentation (3-5 minutes) that you would present to the farmer.

b. Your presentation should include options for the farmer and advice on getting the tools/equipment he/she will need.

2. As the trainees are working on this task, move around the room and stop at each trainee to help them prepare what options and advice to give to the farmer.

3. Once they are prepared, ask each trainee to stand up and present the farmer's options and some advice for him/her to follow.

4. Encourage trainees to challenge each other and provide feedback. Remind them that the farmer has money to spend and his/her land is flat. What could he/she do?

5. At the end, provide your feedback and observations.

Answers to Question 1:
Refer to **3.2 Key Facts**

Points to Remember

- The criteria for selecting tools and equipment includes the type of soil, climate, topography in the area.
- The cost, conditions, durability, and availability of equipment must also be considered.
- Know the crop type to be planted before selecting tools and equipment to use.

Formative Assessment

Explain to the trainees that the following assessment is to be done individually.

1. Explain one advantage and one disadvantage of clay soils.
   Advantage:

   Disadvantage:

2. Identify each statement as either **true** or **false:**
   a. Loam soils are considered nearly perfect soils.

   b. Most disk ploughs are pulled by hand.

   c. Hand tools are best when farming on high slopes.

3. What is a difference between a mouldboard plow and a disk plough?

4. Which of the following is **NOT** part of the criteria for selecting tools and equipment for tillage?
   a. Soil type
   b. Topography
   c. Cost
   d. Availability
   e. None of the above

Answers:

1. Possible Answers: One advantage of clay soils is that they are rich in nutrients. A disadvantage is that clay soil becomes sticky and efficiency is reduced for some tools when it is wet.

2. a. True
   b. False
   c. True

3. A difference between a mouldboard plow and a disk plough is that a disk plough is better suited for hard, clayey, rocky, or sticky ground.

4. e – none of the above

ⓘ Further Information for the Trainer

1. 8 Best Hand Tillers 2016. (2016). *Ezvid Wiki*. Retrieved from https://www.youtube.com/watch?v=h0dObwn_H2w

2. Our Top 10 Tools for Working the Soil. (2017). *Good Housekeeping*. Retrieved from https://www.goodhousekeeping.com/home/gardening/g20706851/garden-digging-tools/

Learning Outcome 3.3: Identify tillage types

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

a. Explain the crop-tillage relationship.

b. Explain tillage types and other factors (soil, soil moisture conservation, climate, etc.)

c. Choose the tillage type based on the type of crop to be grown

Time Required: 5 hours

Learning Methodology: Large group discussion, small group discussion, real-world scenario-based tasks, review and brainstorm using previously learned content, peer-to-peer tasks, individual inquiry-based writing using domain specific content

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, pens
- **Learning materials** - cards/small pieces of paper with key terms written on them (subsoiling, year-round, deep tilling, etc.), separate cards/small pieces of paper with definitions of key terms written on them
- **Audio/visual equipment –** projector, speakers, internet, computer

Preparation:

- ❑ Make key term cards and definitions cards for each trainee (repeat terms and definitions if necessary) using the information from **3.3 Key Facts**.
- ❑ Separate key term cards from definition cards.
- ❑ Preview and prepare all tasks and assessments in advance.

Cross Cutting Issues:

- ✓ **Gender and inclusivity:** Consider gender balance when forming groups.
- ✓ **Standardization culture:** Learn and practice proper procedure and protocol as well as best practices in identifying and selecting tillage types.

Prerequisites:

- Learning Outcome 3.2: Criteria for selecting tools and equipment for tillage

Key Competencies:

Knowledge	Skills	Attitudes
1. State the crop-tillage relationship	**1.** Determine the type of tillage referring to the crop tillage requirement	**1.** Teamwork spirit
2. Explain tillage types and other factors (soil, soil moisture, conservation, climate, etc.)	**2.** Choose the tillage type according to the crop type	**2.** Analytical
3. Explain the tillage types	**3.** Identify the purpose of tillage	**3.** Careful

Steps:

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

1. Ask trainees to think about a time when they had to till the land on their family farm.

a. At what points in the farming process did you till the land?

b. What was the purpose of tilling the land?

2. Facilitate a class discussion and write some of the ideas and answers on the board.

Possible Answers: Seedbed preparation, weed control, erosion control

3. Introduce the learning outcome and the types of knowledge, skills, and attitudes they will acquire by the end of this topic.

Problem Solving Activity

1. Pass out the cards/small pieces of paper with key terms from **3.3 Key Facts** written on them to half of the trainees. Pass out cards/small pieces of paper with definitions of those key terms from **3.3 Key Facts** written on them to the other half of the trainees.

2. Tell the trainees that their task, found under **Topic 3.3 Task 2** in their manuals, is to find the person with their corresponding key term or definition. If they have a term, they need to find the person with the correct definition and vice versa.

3. Encourage them to stand up and walk around, discussing what they think and if the cards align correctly.

4. During the activity, walk around and assist the trainees if they have difficulty understanding the terms and definitions.

5. After all the cards have been matched, ask each pair to present their term and definition to the class.

6. Explain that if there are any errors, the class will revisit this activity after discussing **3.3 Key Facts.**

Guided Practice Activity

1. Read through all of **3.3 Key Facts** with the class, pausing after each one to ask clarifying questions and make sure the trainees understand the terminology used.

2. Direct the trainees back to **Topic 3.3 Task 2** in their manuals and ask volunteers to hold up the correct term card with the correct definition card. Tell them to read the cards out loud to the class (only 2-4 examples as to not be repetitive). Provide time for the trainees to correctly re-match the cards if they need to.

3. Now, ask the trainees to form groups of three people. Each group must read and discuss the scenario found in **Topic 3.3 Task 3:**

To prepare for a school farm, the school wants to till a piece of land for the first time where a large tree has been cut down. Which tilling practices should be performed by the school and why?

4. As the groups are working on **Topic 3.3 Task 3** and discussing their answers, move around the room to help them as needed.

5. Ask different groups to stand up and present their answers to **Topic 3.3 Task 3.**

6. Offer feedback as needed.

Answer to Question 3:
Primary tilling – specifically deep tilling because there will be many roots and other lumps in the soil where the tree was. Secondary tilling will also have to be done to prepare and improve the seedbed by crushing/mixing/pulverizing the soil.

Application Activity

1. Ask trainees to read the scenario from **Topic 3.3 Task 4** and complete the task individually.

   The school wants to prepare seed bed in a field where 2 years passed without tillage. Write an explanation to the school about the different tillage practices that should take place. It should be at least five sentences long.

2. As the trainees are working on this task, move around the room and stop at each trainee to help them with their explanation.

3. Once they are prepared, ask volunteers to stand up and present their writing sample.

4. Encourage the trainees to challenge each other and provide feedback.

5. At the end, provide your own feedback and observations.

Possible Answer to Question 1:
If the field has not been tilled for two years, it will need a lot of preparation in order to grow crops. First, you will need perform primary tilling to open up the compacted soil and remove any lumps and hardpans. You will also need secondary tilling to improve the seedbed and pulverize the soil to be loose. Any large roots or crop residues will need to be cut up and the weeds will need to be destroyed in order to conserve moisture. If these steps are carefully followed, the field will be ready for farming.

For More Answers: Refer to **3.3 Key Facts.**

Points to Remember

- Tillage depth should be changed regularly to avoid soil compaction and hardpan formation.

Formative Assessment

Explain to the trainees that the following assessment is to be done individually:

1. Explain what a hardpan is and how to manage them?

2. What is the difference between primary and secondary tilling?

3. Complete the following sentences:

a. The primary function of tillage is to _____.

b. The purpose of secondary tillage is to improve _____ by increasing soil pulverization.

c. _____ tilling is done in lands of dry farming.

4. Jason is cutting up crop residue and destroying weeds in his garden. Is this considered primary or secondary tillage?

Answers:

1. A hardpan is a hardened layer, typically of clay, occurring in or below the soil that stops drainage and plant growth. You can manage hardpans by regularly changing the depth of the tillage.

2. Primary tillage happens first, and secondary tillage is usually less work/less aggressive to the soil.

3. a. The primary function of tillage is to prepare land for growing crops.
   b. The purpose of secondary tillage is to improve the seedbed by increased soil pulverization.
   c. Year-round tilling is done in lands of dry farming.

4. Jason is performing part of secondary tillage.

Further Information for the Trainer

1. Jaiswal, D. (n.d.). Tillage: Meaning, Types, Objectives and Concepts | Agriculture. Retrieved from http://www.yourarticlelibrary.com/crops/tillage-meaning-types-objectives-and-concepts-agriculture/77213
2. Tillage – Definition – objectives – types of tillage - modern concepts of tillage – main field preparation. (n.d.). *Amil Nadu Agricultural University*. Retrieved from http://eagri.org/eagri50/AGRO101/lec10.pdf
3. Types of Tillage. (n.d.). *TNAU Agritech Portal*. Retrieved from http://agritech.tnau.ac.in/agriculture/agri_tillage_typesoftillage.html

Learning Outcome 3.4: Perform tillage

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

a. Analyse the soil structure type for the purpose of tillage

b. Explain the relationship between tillage type and soil structure

c. Till the land according to the soil structure

Time Required: 5 hours

Learning Methodology: Large and small group brainstorming and discussions, peer-to-peer learning exercises, individual work, analysis of domain-specific multimedia presentations

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper
- **Tilling equipment** - hoes, forks, shovels, rakes, manure fork, machetes, saws, axes, picks, measuring tape
- **Learning materials -** cards/small pieces of paper with terms on them from**3.4 Key Facts** (enough for all groups/trainees), cards/small pieces of paper with definitions on them from **3.4 Key Facts** (enough for all groups/trainees)
- **Audio/visual equipment –** Internet, computer for reference, downloaded videos for reference and activities, projector, speakers

Preparation:

- ❑ Download and preview the following videos for viewing:
  - https://www.youtube.com/watch?reload=9&v=vzz08aUY9lU
    YouTube search: 1. Hand Ploughing – Agriculture
  - https://www.youtube.com/watch?v=I2hCEc7t9dU
    YouTube search: Innovative tool to plough
  - https://www.youtube.com/watch?v=AGjXFGau-Pw
    YouTube search: Ploughing field using bulls or Ox
  - https://www.youtube.com/watch?v=mhNajeeiXjY
    YouTube search: Mounted Disc Plough – UNIVERSAL
- ❑ Prepare and separate cards with the 6 terms and definitions from **3.4 Key Facts** on them. Repeat terms and definitions if necessary.
- ❑ Prepare plot of land near the school and hand tools to practice tillage.

Cross Cutting Issues:

- ✓ **Gender and inclusivity:** Consider gender balance when forming groups.
- ✓ **Standardization culture:** Learn and practice proper terminology and best practices according to standards of tillage.

Prerequisites:

- Soil properties
- Farm tools and equipment
- Types of tillage

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain the soil structure type for tillage purpose	**1.** Analyse the soil structure type for tillage purpose	**1.** Teamwork spirit
2. Explain the relationship between tillage type –soil structure	**2.** Characterize the soil structure for tillage purposes	**2.** Hardworking
3. Explain the characteristics of soil structures	**3.** Till the land according to the soil structure	**3.** Precise

Steps:

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

1. Ask the trainees to brainstorm how many ways there are to plough or till a field.

2. Facilitate a brief discussion and write their ideas on the board. Ask for specific examples.
   a. Examples:
   With animals – oxen, horses, mules, cows, etc.
   With machines – tractors, etc.
   With hand tools – hand ploughs, hoes, picks, rakes, hand tillers etc.

3. Introduce the learning outcome and the types of knowledge, skills, and attitudes they will acquire after this topic. Explain to them that in this learning outcome you will discuss and demonstrate how to perform tillage of a piece of land for farming.

Problem Solving Activity

Prepare the cards with terms on them and cards with definitions on them in advance.

1. Put the trainees into groups of two people for this activity.

2. Read the following instructions from **Topic 3.4 Task 2** and direct the partners to find the card that matches their term or definition:

   The card your trainer gave to you has either a term on it or a definition. If you have a term, you need to find the person with the correct definition. If you have a definition, you need to find the person with the correct term.

3. Encourage them to use all the information they have learned so far in this unit to help them complete the task.

4. Move around the room and assist them as needed.

5. When all partners have found their corresponding team/cards, ask them to read the term cards with the definition cards. The class will then determine whether they think that team is correct.

6. Offer observations and encourage the trainees to challenge each other and ask questions.

7. Explain that they will return to the answers of this activity after discussing **3.4 Key Facts** as a class.

Guided Practice Activity

1. Read through **3.4 Key Facts** with the class, pausing after each one to ask clarifying questions and make sure the trainees understand the terminology used.

2. Direct the trainees back to **Topic 3.4 Task 2** and ask volunteers to hold up the correct term cards with the correct definition cards. Read them out loud to the class (only 2-4 examples as to not be repetitive). Provide time for the trainees to correctly re-match the cards if needed.

3. Now, explain that the trainees will view and listen to some videos about performing tillage.
   a. **Note:** If there is no access to internet, find and show pictures of the various processes and tools. You can also demonstrate with any tools you have.

4. Show each of the four videos to the trainees. This first viewing is to just watch.
   - https://www.youtube.com/watch?reload=9&v=vzz08aUY9lU
     YouTube search: 1. Hand Ploughing – Agriculture
   - https://www.youtube.com/watch?v=I2hCEc7t9dU
     YouTube search: Innovative tool to plough
   - https://www.youtube.com/watch?v=AGjXFGau-Pw
     YouTube search: Ploughing field using bulls or Ox
   - https://www.youtube.com/watch?v=mhNajeeiXjY
     YouTube search: "Mounted Disc Plough – UNIVERSAL

5. Read the questions from **Topic 3.4 Task 3** to the trainees and show them the videos again. Tell them that they will discuss these questions in groups after watching the videos a second time.
   a. What actions do you see in these videos?

   b. What equipment and tools do you see in these videos?

   c. Based on your observations, what type of tillage is happening in these videos (primary or secondary)?

6. Allow trainees to work together in groups of three to answer the questions.

7. As they are answering the questions, move around the groups to check on their progress and assist as needed. You may need to show the videos again.

8. Ask volunteers to present their answers to **Topic 3.4 Task 3.**

9. Provide your observations and feedback.

Answers to Question 5:

a. Ploughing, disking, loosening.
b. Hand plough/hoe, disk plow, manual mouldboard plow pulled by an oxen.
c. Primary because they appear to be opening up the packed soil.

Application Activity

1. Visit a plot of land that has been identified and prepared in advance. Ask trainees to help you bring hand tools and equipment from the school storeroom for practicing tillage.

2. Explain to the trainees that based on what they have learned, discussed, viewed, and practiced in class, they will till a small plot of land outside of the school. Direct them to **Topic 3.4 Task 4** in their manuals.

3. In groups of two people, direct the trainees to first perform primary tillage. Then, tell them to perform secondary tillage of the land. Explain to the trainees that the types of crops to be planted are maize and the type of organic manure to be applied is farmyard manure.

    a. The person doing primary tilling will go first.

    b. The person performing secondary tilling will go after them to break up large clods of soils and stubbles that remain after the primary tilling.

4. While the trainees are tilling this plot, move around to help them and ask each one to explain to you what they are doing and why.
    - For example: Right now, I am loosening the soil destroy weeds and promoting growth by increasing soil aeration and water infiltration.

5. After tilling, ask trainees to explain the difference between the roles of the two processes: primary and secondary tilling.

6. At the end, bring everyone together and encourage them to share their thoughts and challenges regarding the activity.

Answer to Question 4:
Primary is breaking up and loosening the soil and typically requires more effort. Secondary is going after the primary tilling to break up the large clots of soil left behind by primary tilling.

Points to Remember

- The types of tools and climatic conditions are the two keys points to consider before tillage.

Formative Assessment

Explain to the trainees that the following assessment is to be done individually

1. What are the different methods of tillage?

2. What is a benefit of the direct drilling method of tillage?

3. Complete the following sentence:
   a. Cultivation is the act of _____.

4. Identify each statement as either **true** or **false:**

   a. Direct drilling takes place after ploughing.

   b. Shallow cultivation helps maintain organic matter.

   c. Disking is done before and after ploughing.

Answers:

1. The different methods of tillage are ploughing, direct drilling, shallow cultivation, cultivation, disking, and loosening.

2. A benefit of direct drilling is that it results in less soil loss from wind.

3. Cultivation is the act of caring for or raising plants.

4. a. True
   b. True
   c. True

Self-Reflection

1. Ask the trainees to re-take the self-assessment at the beginning of the unit. They should then fill in the table in the Trainee Manual to identify their areas of strength, areas for improvement and actions to take to improve.

2. Discuss trainees' results with them. Identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Further Information for the Trainer

1. Disking. (2019). *The Free Dictionary*. Retrieved from https://encyclopedia2.thefreedictionary.com/Disking
2. The challenge of tillage development in African agriculture. (1993). *FAO SOILS BULLETIN 69*. Retrieved from http://www.fao.org/3/T1696E/t1696e08.html
3. Tillage – Definition – objectives – types of tillage - modern concepts of tillage – main field preparation. (n.d.). *Tamil Nadu Agricultural University*. Retrieved from http://eagri.org/eagri50/AGRO101/index.html
4. Types of Tillage. (n.d.). *TNAU Agritech Portal*. Retrieved from http://agritech.tnau.ac.in/agriculture/agri_tillage_typesoftillage.html
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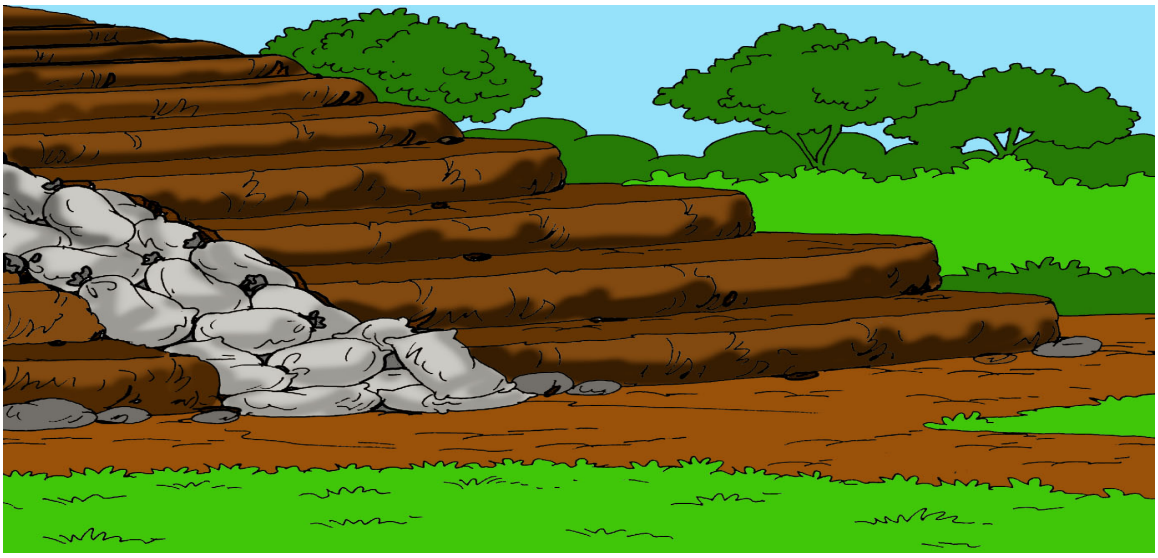
6. Why till the land? (2007). *Knowledgebank*. Retrieved from http://www.knowledgebank.irri.org/ericeproduction/I.1_Why_till_the_land_.html
7. Zydenbos, S. (2008). Direct Drilling. Retrieved December 12, 2019, from https://teara.govt.nz/en/photograph/17584/direct-drilling.

Learning Unit 4: Maintain soil



Learning Outcomes

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

4.1 Apply soil conservation measures

4.2 Acquire soil amendments

4.3 Prepare soil amendments

4.4 Apply soil amendments

Learning Unit 4 Self-Assessment

1. Ask trainees to look at the illustration above (in their Trainee Manuals) and discuss what they see. What topics do they think this unit will include based on the picture? After some brainstorming, share the main topics.

2. Ask trainees to fill out the self-assessment at the beginning of the unit in their Trainee Manuals. Explain that the purpose of the self-assessment is to become familiar with the topics in the unit and for them to see what they know or do not know at the beginning. At the end of the unit, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas that need improvement and actions to take. The self-assessment is not a test!

Learning Outcome 4.1: Apply soil conservation measures

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

a. Apply crop rotation and fallowing practices as soil conservation measures

b. Apply agro-forestry trees and fodder crops as soil conservation measures

c. Apply ditches and trenches as soil conservation measures

Time Required: 2 hours

Learning Methodology: Large and small group brainstorms and discussions, individual work, real-world scenario evidence-based writing response, field visit (real world application)

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper
- **Tools and equipment -** hoes, forks, shovels, rakes, machetes, saws, axes, picks
- **Audio/visual equipment -** internet, computer for reference, reference books, projector, speakers

Preparation:

- ❑ Contact and plan a visit to a farm to observe and discuss soil conservation measures with the farmer. Verify that the farm will have conservation measures for students to observe and practice implementing.
- ❑ Obtain equipment to bring for field visit.
- ❑ Preview and prepare all scenarios/tasks and assessments in advance.

Cross Cutting Issues:

- ✓ **Gender and inclusivity:** Consider gender balance while forming groups.
- ✓ **Standardization culture:** Learn and practice proper terminology and best practices when applying soil conservation techniques.
- ✓ **Environmental sustainability:** Learn and discuss the importance of preventing soil erosion and conserving water when farming.

Prerequisites:

- Soil properties
- Farm tools and equipment
- Types of tillage

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain crop rotation and fallowing practices	**1.** Apply crop rotation and fallowing as soil conservation measures	**1.** Team spirit
2. Explain the uses of planting agro-forestry trees and planting fodder crops	**2.** Apply agro-forestry trees and fodder crops as soil conservation measures	**2.** Analytical
3. Explain the uses of ditches and trenches	**3.** Apply ditches and trenches	**3.** Hardworking

Steps:

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

1. Facilitate a discussion among the class by reading the questions found in **Topic 4.1 Task 1** in the Trainee Manuals:
   a. What does it mean to conserve something?

   b. What are some ways we can conserve the soil on our farms?

2. As the trainees discuss with their partners, ask them to share their ideas and write those ideas on the board/flipchart for the class to see.

3. Introduce the topic to the trainees and turn to the Key Competencies table in their Trainee Manuals. Inform them that this topic will focus on maintaining the soil and applying soil conservation measures.

Problem Solving Activity

1. Explain to the class that if we do not conserve our natural resources, like soil and water, then food production could stop and the environment we live in could be damaged

beyond repair. However, there are small things that farmers can do on their land to help conserve their soil, ensure their crop production and health, and help save the environment.

Explain that many of them have performed these duties in rural communities during Umuganda, such as by digging ditches and trenches on hillsides to prevent soil erosion.

2. Divide the trainees into groups of four people and direct them to read the task from **Topic 4.1 Task 2** in their manuals:
With your groups, brainstorm and discuss what you think these conservation techniques are. After you think of an explanation for each technique, explain their importance.

a. Planting fodder crops

b. Planting trees

c. Digging ditches

d. Letting a field lie fallow

3. As groups discuss these questions, move around and help facilitate discussion.

4. When the trainees have finished discussing, ask groups to present their answers. As they are presenting, tell a volunteer to write their ideas on the board for the class to see.

5. Explain to them that they will return to this list and revise their knowledge after discussing **4.1 Key Facts**.

Guided Practice Activity

1. Read through **4.1 Key Facts** with the class, pausing after each one to ask clarifying questions and make sure the trainees understand the terminology used.

2. Direct the trainees back to **Topic 4.1 Task 2** in their manuals and ask volunteers, one by one, to explain some of the benefits of the soil conservation measures, such as fodder crops, trees, and ditches.

3. Now, inform the trainees to stay in their groups of four people and direct them to **Topic 4.1 Task 3** in their manuals. Instruct them to read and discuss the scenarios and questions with their groups:

   a. Felix is a new farmer who wants to grow coffee as a cash crop. Coffee trees typically take about 3 to 4 years to begin producing beans. He has a plot of land with many large trees with deep root systems on it that he is thinking about cutting down for planting the coffee trees.

   Explain why he should plant his coffee under the large trees and how it will benefit his farm and product if he has forestry among his farm.

   b. Beatrice has a plot of land that she uses to grow potatoes, corn, and sorghum on. Unfortunately, her land always floods. This results in the soil becoming so loose and wet that her plants fall or drown.

   What should Beatrice do about her problem?

4. After all the groups have finished discussing, bring the class together and ask them to share their ideas.

5. Provide feedback and direct them to **4.1 Key Facts** to confirm their answers.

Answers to Question 3:

a. Refer to **4.1 Key Facts - Planting agro-forestry trees**

b. Refer to **4.1 Key Facts - Creating filtration ditches**

Application Activity

Prepare a visit to a farm in advance in order to observe and practice soil conservation measures and interview a farmer on this topic.

1. On the day of the visit, introduce the trainees to the farmer and any workers present.

2. Refer to **Topic 4.1 Task 4** in the Trainee Manuals and direct the trainees to do the following tasks:

a. Walk around the make a list of any soil conservation measures you observe.

b. Write down at least two questions to ask the farmer for a "Question & Answer" session with the farmer.

3. After the trainees have observed the farm and thought of questions to ask the farmer, bring everyone together for a Q&A (Question and Answer) session with the farmer about soil conservation techniques.

4. During this time, facilitate questions that the trainees have for the farmer as a professional in the field.

5. After the Q&A, instruct the trainees to practice any soil conservation activities (prepared and verified in advance) the farmer may need help with, such as digging ditches or trenches, planting trees, etc.

6. After the practical application of soil conservation measures, bring everyone together to share what they learned today. Ask them to express their thoughts and opinions about the field visit.

7. Thank the farmer and any staff who helped.

Points to Remember

- Soil conservation measures include crop rotation, fallowing, planting agro-forestry trees, planting fodder crops, and creating filtration ditches.

Formative Assessment

Explain that the following assessment is to be done individually:

1. Identify each statement as either **true** or **false**:

a. Crop rotation is a soil conservation measure which is done by mixing crops on the same land.

b. Agroforestry is a type of agriculture that incorporates the planting, cultivation, and conservation of trees alongside crops or livestock farming.

c. Planting fodder crops can increase disease.

2. Explain how crop rotation, fodder crop, and ditches prevent soil erosion.

3. What is one benefit of fallowing?

Answers:

1. a. False
b. True
c. False

2. Refer to **4.1 Key Facts**

3. Refer to **4.1 Key Facts**

Further Information for the Trainer

1. Crop Rotation. (n.d.). Retrieved December 12, 2019, from https://www.sciencedirect.com/topics/earth-and-planetary-sciences/crop-rotation.

2. Francisco J. Arriaga, Birl Lowery, 2017: in Soil Health and Intensification of Agroecosytems, Conventional Agricultural Production Systems and Soil Functions

3. HENRY SNYDER, 1896. Case Study: Peter Kenagy. Top Rotations and Soil Organic Matter Levels

4. Moran, M. (2019, March 29). How to Use Crop Rotation in Gardening. Retrieved December 12, 2019, from https://www.wikihow.com/Use-Crop-Rotation-in-Gardening.

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6. Share on Facebook Share on Twitter Print. (n.d.). F4 Qualities needed for agroforestry trees. Retrieved December 12, 2019, from https://learn.tearfund.org/resources/publications/pillars/agroforestry/f4_qualities_needed_for_agroforestry_trees/.

7. What Is Fallow Ground: Are There Any Benefits Of Fallowing Soil. (2018, August 13). Retrieved December 12, 2019, from https://www.gardeningknowhow.com/garden-how-to/soil-fertilizers/what-is-fallow-ground.htm.

Learning Outcome 4.2: Acquire amendments

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

a. Select soil amendments
b. Follow amendment recommendations
c. Identify the role of amendments

Time Required: 2 hours

Learning Methodology: Large and small group discussion/brainstorming, per-to-peer partner work, small group tasks, individual work, inquiry-based writing responses to real-world scenarios

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, pens
- **Reference materials** – Internet, computer, reference books
- **Audio/visual equipment –** projector, speakers
- **Learning materials** - scenario cards for Topic 4.2 Task 4 to be written on larger pieces of paper/cards for trainee groups to have
- **Sample soil amendments** - compost, peat, ash, lime, etc.

Preparation:

- ❑ Preview and prepare all scenarios and assessments in advance.
- ❑ Develop and prepare scenario-based task cards (see Topic 4.2 Task 4).
- ❑ Obtain soil amendments to use as visual aids and examples in the classroom.

Cross Cutting Issues:

- ✓ **Gender and inclusivity:** Consider gender balance while forming groups.
- ✓ **Standardization culture:** Learn and practice proper terminology and best practices when applying soil amendments.
- ✓ **Environmental sustainability:** Learn and discuss the importance of preserving soil health with the proper handling of amendments.

Prerequisites:

- Knowledge of soil properties
- Knowledge of simple calculations

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain the types of soil amendments	**1.** Select soil amendments	**1.** Careful
2. List factors to consider when choosing a soil amendment	**2.** Follow soil amendment recommendations	**2.** Accurate
3. State the role of soil amendments	**3.** Identify the roles of soil amendments	**3.** Precise

Steps:

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

1. Direct trainees to **Topic 4.2 Task 1** in their manuals and tell trainees to discuss the following with a partner:

Think about a time when you added something to soil to help plants/crops grow. What did you add and why did you add it?

2. As they talk with their partners, ask them to share their thoughts and ideas so you can write them on the board/flipchart for the class to see.

3. Introduce the learning outcome and the knowledge, skills, and attitudes they will acquire after this topic. Inform them that this topic discusses acquiring (getting) soil amendments.

Problem Solving Activity

1. Explain that this activity will be an extension of the questions they just discussed from **Topic 4.2 Task 1**. Refer the trainees to **Topic 4.2 Task 2** in their manuals and tell them to discuss the following with their partners:

a. From the content of the sentence below, what do you think "amendment" means?

"Claude did not want to go to work today, so he made an amendment to his schedule."

a. a new job
b. to till soil
c. a change or addition
d. to be late

b. Make a list of what factors need to be considered when selecting a soil amendment.

2. As they are discussing and writing, move around the room and assist each group to help facilitate conversation.

3. When the trainees are finished discussing, ask them to share their answers. Encourage others to agree/disagree and provide feedback.

Guided Practice Activity

1. Before class, arrange examples of soil amendments for viewing around the room and label each one (peat, lime, compost, clay, etc.).

2. Ask trainees to walk around the room and observe the different types of soil amendments on display. As each amendment is discussed while reading 4.2 Key Facts in the next step, ask the trainees to point to the actual amendment displayed in the room.

3. Read through all of **4.2 Key Facts** with the class, pausing after each one to ask clarifying questions and make sure the trainees understand the terminology used.

4. Direct the trainees to work in teams of two for the following activity and then read the task and questions from **Topic 4.2 Task 3** as follows:

The soil where the school garden will be is acidic and sandy with very little organic matter in it. Suppose the school gives you the task of applying soil amendments on this land.

a. What are the factors will you consider while choosing the soil amendment?

b. Which amendments do you recommend?

5. Move around the room and assist the trainees. Refer them to **4.2 Key Facts** to look for guidance and evidence for their answers.

6. When they are finished discussing and writing their responses, ask teams to present their findings. Encourage others to provide feedback and challenge their responses by agreeing or disagreeing.

Answer to Question 2:
Refer to **4.2 Key Facts:** Applying lime will raise the pH. A farmer must know how many hectares his/her land is in order to apply the right quantity of lime. It is also important to have a professional recommendation from a soil testing professional. Adding organic matter, such as compost, manure, and straw will also help the sandy soil build up water retention over time. Soil salinity, texture, pH, and how long the amendment will last are all factors that need to be considered.

Application Activity

1. Divide the trainees into groups of three. Give each group a card with a hypothetical scenario about a farmer's soil on it (See chart below for cards: Write scenarios on paper in advance to give to groups).

2. Refer trainees to **Topic 4.2 Task 4** in their manuals and explain that each group member will have a role as follows:

    a. Writer – Write the answers your group provides to your scenario.

    b. Facilitator – Read the scenario to your teammates and your class.

    c. Presenter – Present your group's answer/advice to the class.

3. Emphasize that everyone in the group must participate and contribute.

Scenario cards:

Emmanuel wants to gradually lower his soil's pH over time.	Clarisse's soil is compacted and very clayey. How can she improve	Rita's soil doesn't hold any water. It is very sandy.	Clarence's soil has a very low pH. What can he do to raise it?

What should he do?	its water penetration and make it looser?	What can she do?	
Yves is a farmer in Rulindo, he has very compacted soil and his pH is too high. He wants to add amendments, but he does know which ones. What should he do?	Claudine wants to know how applying organic matters to her soil will benefit it.	Jean Claude's soil does not hold water or nutrients. What should he do?	Muhammed's soil does not drain and roots cannot go down deep. What should he do?
What materials can Alain add to his soil to help it hold water?	Jean Bosco's soil is high in salinity. What can he do to lower it overtime?	Liliane's soil is high in pH and salinity. What can she do to lower it over time?	How can Alice obtain straw and manure for the soil in her garden? What will it help?
How can Francoise obtain sawdust for the soil in his garden? What will it help?	What should Jean de Dieu consider before applying an amendment to his soil?	What materials can Gad add to his soil to help it hold water?	Donata's soil doesn't hold any water. It is very sandy. What can she do?

4. Provide time for each group to discuss and refer to **4.2 Key Facts** for assistance.

5. Move around the room offering advice and help as needed.

6. When the trainees are finished writing and discussing, ask groups to present one by one. Remind groups that each person must fulfil their role.

7. Offer feedback as needed.

Points to Remember

- Soil properties to consider in choosing soil amendment include soil structure, soil texture, and soil pH.

Formative Assessment

Explain that the following assessment is to be done individually:

1. Explain why a farmer would need to apply soil amendments.

2. Identify the following statements as either **true** or **false**:
   a. Gypsum raises the pH.

   b. Lime lowers the pH.

   c. Manu, peat, and compost are inorganic amendments.

   d. Plant-based composts are low in salt.

3. What does soil texture mean? Give an example.

4. When is it ok to use soil amendments?

Answers:

1. Refer to **4.2 Key Facts**.

2. a. False
   b. False
   c. False
   d. True

3. Soil texture, or the way a soil feels, reflects the size of the soil particles. Sandy soils have large soil particles and feel gritty. Clay soils have small soil particles and feel sticky.

4. You can add amendments to soil anytime, but the best times for working it into an existing garden are in the spring before planting, and in the fall when putting the garden to bed.

ⓘ Further Information for the Trainer

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2. Choosing a Soil Amendment - 7.235. (n.d.). Retrieved December 12, 2019, from https://extension.colostate.edu/topic-areas/yard-garden/choosing-a-soil-amendment/.
3. Soil Amendment. (n.d.). Retrieved December 12, 2019, from https://www.sciencedirect.com/topics/earth-and-planetary-sciences/soil-amendment.
4. Soils, Crops and Fertilizer Use. (n.d.). Retrieved December 12, 2019, from http://www.nzdl.org/gsdlmod?e=d-00000-00---off-0hdl--00-0----0-10-0---0---0direct-10---4-------0-1l--11-en-50---20-about---00-0-1-00-0--4----0-0-11-10-0utfZz-8-00&cl=CL1.16&d=HASH412cd503b5262205ac14c6.13.4>=1.

Learning Outcome 4.3: Prepare amendments

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

a. Choose organic and inorganic amendments

b. Characterize raw material for inorganic amendments preparation

c. Prepare soil amendments

Time Required: 2 hours

Learning Methodology: Large and small group discussion/brainstorming, per-to-peer partner work, small group tasks, individual work, inquiry-based writing responses to real-world scenarios

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, pens
- **Various organic amendments** - peat, bark, moss, compost, manure
- **Various inorganic amendments** - perlite, vermiculite, rubber bark (tire chunks), sand
- **Reference materials** - Internet, computer for reference, reference books

Preparation:

- ❑ Preview and prepare all scenarios and assessments in advance.
- ❑ Obtain and prepare all soil amendments for trainee practical application tasks.

Cross Cutting Issues:

- ✓ **Gender and inclusivity:** Consider gender balance while forming groups.
- ✓ **Standardization culture:** Learn and practice proper terminology and best practices when applying soil amendments.
- ✓ **Environmental sustainability:** Learn and discuss the environmental impacts of organic and inorganic fertilizers.

Prerequisites:

- Soil properties
- Crop nutrient requirement

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain the types of organic and inorganic amendments	**1.** Choose organic and inorganic amendments	**1.** Collaborative
2. Characterize raw materials for preparation of organic amendments	**2.** Prepare organic amendments	**2.** Careful
3. Characterize raw materials for preparation of inorganic amendments	**3.** Prepare inorganic amendments	**3.** Accurate

Steps:

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

1. Facilitate a class discussion by referring to the following questions from **Topic 4.3 Task 1** in the Trainee Manuals:

a. What organic or inorganic fertilizers have you used before on your family's land?

b. Why did you choose to use that specific substance for the soil?

2. If the trainees need you to, explain the terms "organic" and "inorganic" as follows:

- **Organic:** relating to or coming from living matter.
- **Inorganic:** not consisting of or deriving from living matter.

3. As trainees are discussing, ask them to share their ideas and answers so you can write them for the class to see.

a. Ask guiding questions, such as "Why did you use that for the soil?"

4. Introduce the learning outcome and Key Competencies table which includes the types of knowledge, skills, and attitudes they will acquire by the end of this topic. Explain to the

class that **Topic 4.3** will be an extension of **Topic 4.2** and they will learn more about preparing soil amendments.

Problem Solving Activity

1. Divide the trainees into groups of three and refer them to **Topic 4.3 Task 2** in their manuals:

   a. Based on what you already know, what do you think the advantages and disadvantages of organic and inorganic fertilizers are? Make a list.

   b. Discuss why a farmer would choose one over the other.

2. Provide time for each team to go back through past **Key Facts** from **Units 3 and 4** for assistance. Move around the room and assist them using the definitions of organic and inorganic that were provided.

3. When the groups are finished, ask each group to share their lists out loud with the class. Encourage others to ask questions and provide feedback.

4. Explain that they will verify their responses after discussing **4.3 Key Facts** in the next activity.

Guided Practice Activity

1. Read through **4.3 Key Facts** with the class, pausing after each one to ask clarifying questions and make sure the trainees understand the terminology used.

2. For the **Organic vs. Inorganic section of 4.3 Key Facts**, divide the trainees into five groups and assign each group a section. Each group will read and study that section for five to ten minutes. Then, they must present it to the class in the same order as within **4.3 Key Facts**.

3. During the presentations, direct the trainees to listen carefully and ask questions to seek clarification on organic compared to inorganic amendments.

4. Now, tell the trainees to go back into their groups of three and refer to the following scenario and questions from **Topic 4.3 Task 3** in their manuals:

   The soil of the school farm site is acidic, less permeable (leaky/porous/penetrable) and some parts of the farm have less water holding capacity and a depletion of plant nutrients.

   a. What should be the raw material to be used for improving (amending) that soil.

   b. Explain why that amendment will overcome the problem mentioned above.

5. Provide each group with time to discuss and select a soil amendment. When they are finished, ask groups to share their explanations.

6. Provide observations and feedback as needed.

Answers: Refer to **4.3 Key Facts**.

Application Activity

1. Refer to **Topic 4.3 Task 4** in the Trainee Manuals and ask trainees to help farmers improve their soil with the following characteristics by writing responses to the questions:
   Little water retention, little permeability, little water infiltration, little drainage, little aeration and poor soil structure, acidic soil, and few plant nutrients.

   a. What should be the raw material to be used for preparing soil amendment of farmers mentioned above?

   b. Explain to the farmer how to prepare the soil amendment for his soil.

2. As the trainees are working on the task, walk around the room to stop and help, offer advice, or give examples.

3. When they are finished with their written responses, ask them to share their answers out loud with the class.

4. Provide feedback and observations as needed

Points to Remember

- Common organic matter raw materials include plant materials, manure, compost, and sawdust.
- Common inorganic raw materials include vermiculite, perlite, rubber (tire), and sand.

Formative Assessment

1. Identify each statement as either **true** or **false:**

a. Composting material are used to prepare organic amendments.

b. Sandy soil is used to improve drainage in clay soil.

2. Identify the raw materials in an amendment used to improve each of the following:

a. Increase soil permeability:

b. Increase soil pH:

c. Increase soil water holding capacity:

3. Explain the difference between organic and inorganic amendments.

4. Name one advantage of using organic amendments and one advantage of using inorganic amendments.

Answers:

1. a. True
b. True
2. Refer to **4.3 Key Facts**
3. Refer to **4.3 Key Facts**
4. Refer to **4.3 Key Facts**

ⓘ Further Information for the Trainer

1. Choosing a Soil Amendment - 7.235. (n.d.). Retrieved December 13, 2019, from https://extension.colostate.edu/topic-areas/yard-garden/choosing-a-soil-amendment/.
2. Miller, R. (2018, December 17). Inorganic Fertilizer Vs. Organic Fertilizer. Retrieved December 13, 2019, from https://homeguides.sfgate.com/inorganic-fertilizer-vs-organic-fertilizer-39528.html.
3. What is a Soil Amendment? (2019, June 6). Retrieved December 13, 2019, from https://yardcare.toro.com/restore/tips-facts-restore/what-is-a-soil-amendment/.

Learning Outcome 4.4: Apply amendments

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

a. Identify soil amendment application methods
b. Choose amendment application methods
c. State the relationship of soil amendments and soil amendment application methods
d. Apply soil amendments

Time Required: 2 hours

Learning methodology: Large and small group discussion/brainstorming, peer-to-peer partner work, small group tasks, individual work, inquiry-based writing responses to real-world scenarios, field-work application

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, pens
- **Various organic amendments** - peat, bark, moss, compost, manure
- **Various inorganic amendments** - perlite, vermiculite, rubber bark (tire chunks), sand
- **Soil amendment tools** - Fertilizer spreader, buckets, hand shovels, watering can, measuring tape, rope
- **Reference materials –** internet, computer, reference books

Preparation:

- ❑ Preview and prepare all scenarios and assessments in advance.
- ❑ Obtain and prepare all soil amendments and soil amendment tools and equipment for trainee practical application tasks.
- ❑ Locate and prepare land at or near the school for trainees to practice application methods in small plots of $1m^2$ each.

Cross Cutting Issues:

- ✓ **Gender and inclusivity:** Consider gender balance while forming groups.
- ✓ **Standardization culture**: Learn and practice proper terminology and best practices when applying soil amendments.
- ✓ **Financial education**: Learn and discuss cost effective ways to apply soil amendments.

Prerequisites:

- Soil properties
- Criteria for selecting soil amendments

Key Competencies:

Knowledge	Skills	Attitudes
1. List soil amendment application methods	**1.** Choose amendment application methods	**1.** Accurate
2. Explain soil amendment application methods	**2.** Calculate soil amendments	**2.** Careful
3. State the relationship of soil amendments and soil amendment application methods	**3.** Apply soil amendments	**3.** Collaborative

Steps:

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

1. Facilitate a class discussion and review the following items with the trainees:

a. Define soil amendments.

b. What are the two different categories of soil amendments?

c. What are some of the raw materials used in soil amendments?

2. As trainees discuss and review with a partner. After their discussions, ask three trainees to write out the answers to the following questions on the board/flipchart for the class to see.

3. Ask the class if there is anything missing from the answers provided on the board. Encourage input and feedback from everyone.

4. Introduce the learning outcome and the Key Competencies table, which illustrates the types of knowledge, skills, and attitudes they will acquire by the end of this topic. Explain that this topic will complete our discussion about soil amendments; it is about applying amendments.

Problem Solving Activity

1. Inform trainees that they may work with partners for **Topic 4.4 Task 2**. Explain that they should use the knowledge they already have to read and determine which term belongs to which definition regarding the application of soil amendments. They must do this without looking at **4.4 Key Facts**.

2. As the trainees are working, move around the room to ask questions and offer help as needed. Encourage them to discuss with one another and problem solve together.

3. Request six trainees to match letters A – F. Encourage others to agree or disagree and explain why.

4. Inform the trainees that they will discover the correct answers after discussing **4.4 Key Facts.** They will have the opportunity to go back and revise their responses to **Topic 4.4 Task 2.**

Answers:
A. Broadcasting
B. Plough
C. Band
D. Spot
E. Spray
F. Localized

Guided Practice Activity

1. Read through all of **4.4 Key Facts** with the class, pausing after each one to ask clarifying questions and make sure the trainees understand the terminology used.
   a. Be sure to complete the calculation examples with the trainees more than once. Verify that they understand the math and the reasoning behind it.

2. Encourage the trainees to return to their matching activity from **Topic 4.4 Task 2** and revise their answers if they need to. Ask 2-3 trainees to share a term and its definition.

3. Ask trainees to form groups of three and refer them to **Topic 4.4 Task 3**. Instruct them to read the following scenario and discuss the questions in their groups:

   Jean Pierre is a potato farmer in Rubavu. He plans to plant seeds next week. His land is flat, and he does not have any machinery or large equipment. Provide Jean Pierre with the following advice:

   a. Where in relation to his plants, should he apply his fertilizer and why?

   b. What method(s) do you recommend and why?

   c. What recommendation do you have for applying nitrogen fertilizer on Jean Pierre's potato farm?

   Answers: Refer to **4.4 Key Facts**

4. Provide each group with time to discuss and locate evidence for their answers in **4.4 Key Facts.**

5. Move around the room and refer trainees to **4.4 Key Facts.** Encourage them to discuss with one another and explain their answers to you.

6. After the trainees have finished the task, ask groups to share their answers. Encourage them to support their answers with evidence from **4.4 Key Facts.**

Application Activity

Prepare land near the school for the trainees to practice on as well as the amendments and application equipment.

1. Using the same groups of three, take the trainees to the school farm site/to a nearby plot of land and assign each group three plots of $1m^2$. Provide soil amendments and application equipment from the school storeroom. Refer trainees to **Topic 4.4 Task 4** and provide the specifications for each plot:

a. Your group will be given three small plots of land that are $1m^2$ each. With a tape measurer, verify the size of your plots. Each group is responsible for dividing the three small plots among your members:

i. One plot is acidic. Lime and available organic amendments are to be applied.

ii. Another plot is where potatoes will be planted and both organic manure and inorganic fertilizers will be used depending on their availability.

iii. Another plot needs sand to increase soil permeability. Select the method to be used and explain your choice.

b. Demonstrate applying the recommended amendments using all the available materials, tools, and equipment.

c. In your notebook, record which plot you chose, your application procedure, and your explanation for choosing that procedure. Be prepared to explain your process to your trainer and class.

2. As the group members are working, walk around to discuss the processes with trainees and to offer help as needed. Encourage them to also discuss challenges and give advice to each other.

3. Ask groups to share their written record of their process at the end of the activity.

4. Provide feedback and observations as needed.

Answers:
Refer to **4.4 Key Facts**

Points to Remember

- When applying soil amendments, consider the types of crop to be grown and research their nutrient specifications.

Formative Assessment

1. Explain the difference between broadcasting placement and spot placement when applying soil amendments.

2. Identify each statement as either **true** or **false:**

a. In acidic soil sand is applied to increase soil pH depending on the crop grown.

b. Organic amendments improve soil water holding capacity.

c. Broadcasting can be done with a vehicle, a manual tool such as a spreader, or by hand.

d. To determine the fertilizer rate for a particular nutrient, multiply the rate of the desired nutrient by 100 and divide by the percentage of the nutrient in the fertilizer.

3. Explain the band method of applying amendments.

Answers:

1. Refer to **4.4 Key Facts**

2. a. False
b. True
c. True
d. True

3. Refer to **4.4 Key Facts**

Self-Reflection

1. Ask trainees to re-take the self-assessment at the beginning of the unit. They should then fill in the table in the Trainee Manual to identify their areas of strength, areas for improvement and actions to take to improve.

2. Discuss trainees' results with them. Identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Further Information for the Trainer

1. Choosing a Soil Amendment - 7.235. (n.d.). Retrieved December 13, 2019, from https://extension.colostate.edu/topic-areas/yard-garden/choosing-a-soil-amendment/.
2. What is a Soil Amendment? (2019, June 6). Retrieved December 13, 2019, from https://yardcare.toro.com/restore/tips-facts-restore/what-is-a-soil-amendment/.

Learning Unit 5: Assist in sterilizing soil for organic growing mediums

Learning Outcomes

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

5.1 Identify soil for organic growing mediums

5.2 Identify tools and equipment for soil collection and sterilization

5.3 Treat soil for organic growing mediums

Learning Unit 5 Self-Assessment

1. Ask trainees to look at the illustration above (in their Trainee Manuals) and discuss what they see. What topics do they think this unit will include based on the picture? After some brainstorming, share the main topics.

2. Explain that this Learning Unit will focus on preparing the soil for organic growing mediums through sterilization. They will learn how to identify the soil, tools, and equipment for treating organism mediums, as well as how to carry out the treatment process.

3. Ask trainees to fill out the self-assessment at the beginning of the unit in their Trainee Manuals. Explain that the purpose of the self-assessment is to become familiar with the topics in the unit and for them to see what they know or do not know at the beginning. At the end of the unit, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas that need improvement and actions to take. The self-assessment is not a test!

Learning Outcome 5.1: Identify soil for organic growing medium

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

a. Select the site for organic growing media
b. Differentiate growing media
c. Characterize an organic growing media site

Time Required: 2 hours

Learning Methodology: Large and small group discussion/brainstorm, presentation, peer-to-peer partner work, small group tasks, individual work, inquiry-based writing responses to real-world scenarios.

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, pens
- **Reference materials –** internet, computer, reference books
- **Audio/visual equipment –** projector, speakers
- **Composting materials -** hoe, shovel, gloves (PPE), used tea leaves or coffee grounds, grass clippings, dead leaves, toilet paper rolls, vegetable scraps, etc. thermometers, watering cans and a supply of water

Preparation:

- ❑ Preview and download the following videos for Task 3:
  https://www.youtube.com/watch?v=hVT9fAJllRk
  https://www.youtube.com/watch?v=x4JssQPTYF8
- ❑ Obtain and set up computer, projector, and speakers for multimedia activity.
- ❑ Obtain and prepare materials for composting. Arrange outside in an area of land reserved for the trainees.
- ❑ Prepare a small area of land outside of the school for the trainees' practical application.

Cross Cutting Issues:

- ✓ **Standardization culture:** Learn and practice proper terminology and best practices when identifying different growing mediums
- ✓ **Environmental sustainability:** Learn and discuss the process of creating compost for organic growing mediums.

Prerequisites:

- Soil properties
- Soil amendments

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain the role of organic growing mediums	**1.** Select from various growing media	**1.** Team spirit
2. Differentiate growing media	**2.** Characterize the site for organic growing	**2.** Analytical
3. State the characteristics of the site for organic growing	**3.** Characterize growing media	**3.** Accurate

Steps:

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

1. Refer trainees to **Topic 5.1 Task 1** in their manuals. Facilitate a class discussion using the following questions:
   a. What types of soil have you studied so far?
   b. What are they?
   c. What are their properties?

2. Facilitate the group discussion about soil types and their properties based on what the trainees remember from previously topics. Ask them to share ideas and answers for you to write on the board for the class to see.

3. Introduce the learning outcome and Key Competencies table with the types of knowledge, skills, and attitudes they will acquire by the end of this topic. Explain that this topic will be an extension of soils as growing mediums and they will specifically learn about identifying soils for organic growing media.

Problem Solving Activity

1. Acknowledge that the trainees have learned a lot of information that seems very similar. It can sometimes be confusing. The purpose of this activity is to help differentiate the terminology and aid the trainees' understanding for this new topic.

2. Ask trainees to form groups of three and refer them to **Topic 5.1 Task 2** in their manuals. In their groups, tell trainees to read and answer the follow questions:
   a. What is the difference between a growing medium and an amendment?

   b. Based on what you know about the meaning of organic is, what are some things you would avoid if you were growing organic crops?

   c. Using what you know, try to define the following terms:
      - Greenhouse growing system
      - Potted growing system
      - Open field growing system

3. As trainees are completing the task, encourage them to use notes from previous topics to guide them. However, they should not look at **5.1 Key Facts** for this learning outcome.

4. Walk around the room and assist the trainees. Guide them in making inferences about the terminology and definitions using evidence they already know.

5. Ask groups to share their responses and encourage others to challenge them by agreeing or disagreeing and explaining why.

6. Inform them that they will return to this task after discussing **5.1 Key Facts** to revise their responses if necessary.

Guided Practice Activity

1. To engage the trainees and give them more ownership of the content, divide the class into small groups. Tell the groups to read through all of **5.1 Key Facts** by reading and studying the content one section at a time.

2. After each group has read and studied the content of **5.1 Key Facts**, ask one person from each group to stand up and read it to the class so that others may follow along.

3. After each section of **5.1 Key Facts** has been read aloud, pause and provide time for any questions or clarifications. As you read, tell trainees to go back to **Task 2** to revise their previous responses. Ask the questions from **Task 2** to make sure everyone participates and understands.

   a. What is the difference between a growing medium and an amendment?

   Answer*:* A growing medium is the soil and location where a plant is grown, whereas an amendment is something that is added to the medium to enhance or sustain growth.

   b. Based on what you know about the meaning of organic is, what are some things you would avoid if you were growing organic crops?

   Answer*:* Pesticides, chemical fertilizers, genetically modified organisms, antibiotics and growth hormones.

   c. Using what you know, try to define the following terms:
   - Greenhouse growing system:
   - Potted growing system:
   - Open field growing system:

   Answers: All definitions in **5.1 Key Facts**.

4. After all of the groups have read **5.1 Key Facts** and revised their answers from **Task 2**, play the following videos:

   a. https://www.youtube.com/watch?v=hVT9fAJllRk
   YouTube search: Perfect Soil & Growing Medium for Organic Gardening

   b. https://www.youtube.com/watch?v=x4JssQPTYF8
   YouTube search: How to Make Hot Compost Complete Guide

5. Direct trainees to **Topic 5.1 Task 3** in their manuals. Give them time to read the following questions which relate to the videos. Play the videos a second time and tell trainees to take notes on the answers to these questions:

a. In the video on perfect soil and growing mediums, what is one way to grow crops that was not mentioned in **5.1 Key Facts**? What are the benefits of this method?

b. In the video about how to make compost, what are the ingredients needed to make compost? Are these readily available in Rwanda?

c. What is something new you learned in the videos? How does this relate to the information provided to you in **5.1 Key Facts**?

6. After the videos, provide the trainees with time to write their answers and discuss with a partner.

7. Call on trainees to share their responses. Encourage others to provide feedback and observations.

Answers to Question 5:

a. In-ground beds and raised beds. These are good if a farmer does not have a lot of land and wants more control over the root systems and growing conditions.

b. Carbon, Nitrogen, Water, Air – dead leaves, grass clippings, vegetable scraps, coffee grounds, toilet paper rolls. Yes, all of these are widely available in Rwanda.

c. Answers depend on individual trainee's understanding and response.

Application Activity

Prepare composting ingredients and equipment in an area outside of the school in advance.

1. Bring trainees to the area you prepared. Divide them into groups of three and refer them to **Topic 5.1 Task 4** in their manuals. Tell them to read the following instructions and complete the tasks with their groups:

Today you are going to prepare your own compost to mix with soil and use as an organic growing medium for crops.

With the available equipment and materials, complete the following tasks:

a. Make a list of the ingredients and tools available that you will need for making your compost pile.

b. Write an explanation for the process of making your own compost.

c. Demonstrate how to begin the composting process.

d. Explain the benefits of using organic growing mediums, such as compost.

2. As the trainees work with their groups, discussing and mixing their compost, walk around and ask them to demonstrate to you the following:

a. Measure the temperature of the pile.

b. Explain the process and ingredients for composting.

c. Explain the benefits of using organic growing mediums.

3. Offer help and advice as needed.

4. At the end of the activity, ask the groups to share their processes and show their work.

5. Provide your observations and feedback. Explain to the trainees that this was just for practice, as compost takes months to break down. If possible, to maintain the learning process, periodically mix the compost piles, water them, and record their temperatures. As noted in the video, it will take approximately two months for it to be ready to use as a growing medium or soil amendment.

Points to Remember

- The major functions of growing mediums are to physically support plant growth, allow for maximum root growth, and supply roots with necessities such as water, air, and nutrients.

Formative Assessment

Explain to the trainees that the following assessment is to be done individually.

1. What are the three major functions of growing mediums?

2. What is a benefit and a disadvantage of growing crops in a greenhouse?

3. Why is peat moss an excellent growing medium?

4. Which of the following is NOT a factor when selecting a location for a growing medium?
   a. topographic requirements of a crop
   b. soil requirements of the crop
   c. accessibility to infrastructure/utilities/necessary resources
   d. climate requirements of a crop
   e. none of the above

5. Why is it important to practice organic farming when possible?

Answers:

1. Major functions of growing mediums:
   - Physically support plant growth.
   - Allow for maximum root growth.
   - Supply roots with necessities such as water, air, and nutrients.

2. Refer to **5.1 Key Facts**

3. Refer to **5.1 Key Facts**

4. E: none of the above

5. Refer to **5.1 Key Facts**

Learning Outcome 5.2: Identify tools and equipment for soil sterilization

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

a. Select tools and equipment used for soil collection and sterilization

b. Characterize tools and equipment used for soil collection and sterilization

c. Explain the selection criteria for tools and equipment used for soil collection and sterilization

Time Required: 2 hours

Learning Methodology: Large group discussion and review of previously learned content, small group discussion, peer-to-peer tasks, individual work based on real-world scenarios

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, pens
- **Reference materials –** internet, computer, reference books
- **Audio/visual equipment –** projector, speakers
- **Sterilization tools** - Sterilizer, blades, tubes, container, gloves, goggles (PPE), hook, oven, saws, motor, sieve, weight device, sheeting, sacks, plastic bag

Preparation:

- ❑ Preview all tasks and assessments in advance.
- ❑ Obtain and prepare various tools for display in the classroom.

Cross Cutting Issues:

- ✓ **Gender and inclusivity:** Consider gender balance while forming groups.
- ✓ **Standardization culture:** Learn and practice proper terminology and best practices when identifying and selecting tools and equipment for collection and sterilization.
- ✓ **Financial education:** Discuss the importance of identifying and selecting tools and equipment in order to save money and reduce repair/replacement costs.

Prerequisites:

- Tools and equipment for soil collection
- General care and maintenance of tools and equipment

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain the characteristics of tools and equipment used for soil collection and sterilization	**1.** Select tools and equipment used for soil collection and sterilization	**1.** Team spirit
2. State the selection criteria for tools and equipment used for soil collection and sterilization	**2.** Characterize tools and equipment used for soil collection and sterilization	**2.** Analytical
3. Explain factors for choosing tools and equipment for soil collection and sterilization	**3.** Identify key factors for selecting tools and equipment for soil collection and sterilization	**3.** Honest

Steps:

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

1. Facilitate a class discussion by referring to **Topic 5.2 Task 1** in the Trainee Manuals. Tell trainees to complete the task with a partner.

a. Make a list of the tools and equipment you've learned about in the soil collection and analysing processes.

2. As the trainees are talking with their partners encourage them to call out their ideas and responses so you can write them on the board for the class to see. This should be a review for the trainees.

3. Explain to the trainees that the next two topics in this unit will build on content they previously learned, and this topic will rely on review.

4. Introduce the learning outcome and the types of knowledge, skills, and attitudes they will acquire after this topic. Explain that this topic will be about identifying tools for soil sterilization.

Problem Solving Activity

1. Ask the trainees to form groups of three people and refer them to **Topic 5.2 Task 2** in their manuals. Tell each group to discuss the following:

   You've learned about tools for collecting and analysing soil as well as how to clean and maintain those tools.

   a. Do you think the tools used to sterilize soil are different from those used to collect soil? Why or why not?

   b. What characteristics in tools and equipment should a professional look for?

   c. Think about what you have learned from past topics. What factors should you consider when selecting tools and equipment for soil collection and sterilization?

2. Encourage the groups to use their notes and Trainee Manuals to review and discuss previous content. Help facilitate discussion by asking guiding questions, such as, "Do you remember what it means to sterilize?" and "In what learning outcome did we learn about sterilization?"

3. When each group has finished discussing and answering the questions, ask the groups to present their responses. Encourage others to comment or provide feedback on other groups' responses.

4. Provide your feedback and observations as needed.

Guided Practice Activity

1. Read through all of **5.2 Key Facts**, pausing after each one to ask questions and make sure the trainees understand the content.

2. To help the trainees better understand the material and have a meaningful review, displayed some tools and equipment from **5.2 Key Facts** in front of the classroom for everyone to see. Point to a piece of equipment or tool and ask trainees to identify what it is.

3. For the next activity, direct the trainees to work with the person sitting next to them and refer them to **Topic 5.2 Task 3** in their manuals. Tell them to discuss the following questions:

   The school has different tools and equipment for the collection and sterilization of soil to be used as a growing medium.

   a. What characteristics will you look for while selecting the best tools and equipment for these tasks?

   b. What factors affect your choice of tools and equipment used for collecting and sterilizing soil?

   c. How the process of identifying and selecting tools and equipment of collecting and sterilizing soil similar to other processes on the farm?

4. While the trainees are working together, walk around the room, stopping at each team to facilitate discussion and help them use evidence from **5.2 Key Facts** as well as the knowledge they have from past learning outcomes/topics.

5. Ask each group to stand up and present their findings. As they do this, write common responses on the board/flipchart for the class to see.

6. Provide clarification and support as needed, especially with the **part c.**

Answers to Question 3: Refer to **5.2 Key Facts**.
The answer to the last question should connect to identifying locations, amendments, maintenance procedures, etc. Trainees should begin to realize that there is a common process when selecting/identifying anything that will be significant to the farmer's enterprise/business.

Application Activity

1. For this activity, instruct trainees to work individually while you walk around and assist them with the following task, which can be found under **Topic 5.2 Task 4** in their manuals:

You've been asked to create a brochure that helps farmers properly identify and select the tools and equipment needed for collecting and sterilizing soil. Your brochure must include the following content:

a. Illustrations (drawings/pictures) that help the farmer understand the selection process.

b. Ten helpful tips/advice that the farmer should consider when selecting equipment, including the qualities or characteristics he/she should look for in tools and equipment.

c. Give your brochure a title. Make the information easy to understand and attractive to look at.

2. Provide a sample brochure to show trainees as an example for how to make a neat brochure/pamphlet that contains helpful information.

3. After the trainees finish, tell each person to give their brochure to someone else to read and look at. Ask them to make sure their colleague's brochure is easy to understand and helpful to farmers.

4. Ask several trainees to share their finished products. Provide observations and feedback as needed.

Answers: Refer to **5.2 Key Facts**.

Points to Remember

- The cost and the scale (size and number of crops) of farming is the main criteria for choosing tools and equipment for soil collection and sterilization.

Formative Assessment

Explain to the trainees that the following assessment is to be done individually.

1. Which of the following are NOT criteria to consider when selecting tools?
   - **a.** how easy it is to operate
   - **b.** type of soil
   - **c.** how much it costs
   - **d.** the size and number of crops grown on the farm
   - **e.** none of the above

2. Explain why the availability of spare parts is an important factor when selecting tools and equipment.

3. Identify each statement as either **true** or **false:**
   - **a.** The tools should be strong enough to withstand intensive use at the work site, and resistant to wear so that they have a long working life.
   - **b.** The best choice of tools stays the same from place to place
   - **c.** Excavation/Striking tools should be forged (made) from a single piece.

Answers:

1. E: none of the above
2. Refer to **5.2 Key Facts**
3. a. True
   b. False
   c. True

Further Information for the Trainer

1. Tips to Sterilize Potting Soil, Garden Soil and Soil For Seeds. (2019, August 7). Retrieved December 15, 2019, from https://www.gardeningknowhow.com/garden-how-to/soil-fertilizers/sterilizing-soil.htm.

Learning Outcome 5.3: Treat soil for growing medium

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

a. Identify soil sterilization methods for growing mediums

b. Select soil sterilization methods for growing medium

c. Sterilize the soil for a growing medium

Time Required: 2 hours

Learning Methodology: Large group discussion and brainstorm, peer-to-peer learning tasks, small groups discussion, individual work, evidence-based writing response using domain-specific content

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, pens
- **Reference materials –** internet, computer, reference books, downloaded videos
- **Audio/visual equipment –** projector, speakers

Preparation:

❑ Download and preview the following videos:

- https://www.youtube.com/watch?v=JjX9Z4aTLoo
  YouTube search: Gardening Preparation Tips: How to Sterilize a House Plant's Potting Soil
- https://www.youtube.com/watch?v=fUOfQQVubz0
  YouTube search: How to Sterilize Soil in The Garden: Grow Guru

❑ Obtain and prepare projector and speakers for viewing videos with trainees.

❑ Prepare your own written response to **Topic 5.3 Task 3**.

Cross Cutting Issues:

✓ **Gender and inclusivity:** Consider gender balance while forming groups.

✓ **Standardization culture:** Learn and practice proper terminology and best practices when sterilizing and treating soils.

✓ **Environmental sustainability:** Discuss how properly sterilizing and trading soil must not be destructive or harmful to the environment.

Prerequisites:

- Handling chemical products
- Care and maintenance of tools and equipment

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain soil sterilization methods for growing mediums	**1.** Identify soil sterilization methods	**1.** Accurate
2. List selection criteria for soil sterilization methods	**2.** Select soil sterilization methods	**2.** Careful
3. State the benefits of soil sterilization	**3.** Sterilize the soil for growing medium	**3.** Collaborative

Steps:

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

1. Facilitate a class discussion by referring to the questions from **Topic 5.3 Task 1** in the trainees' manuals:

a. What is the meaning of sterilization?

b. Where is sterilization used and how is it important in everyday life?

2. Encourage trainees to use their notes and information from **Topic 1.2** for reference.

3. As they are talking to each other, ask trainees to share their ideas and responses so you can write them for the class to see.

4. Introduce the learning outcome and Key Competencies table with the knowledge, skills, and attitudes trainees will gain in this topic. Explain that they are going to learn and discuss how to treat and sterilize soil to be used as a growing medium.

Problem Solving Activity

1. Direct trainees to form groups of three people and refer them to **Topic 5.3 Task 2** in their manuals. Tell trainees to read and discuss the following with their groups:

You have already learned and practiced sterilizing tools and equipment in **Topic 1.2**. It is also essential to sterilize soil before planting to ensure the best growth and health of your plants.

a. How do you think disinfecting and sterilizing soil to use as a growing medium is similar to or different from sterilizing tools and equipment?

b. What methods do you think there are to sterilize soils?

2. Encourage trainees to use their notes and resources from **Topic 1.2** to review sterilization and help them brainstorm responses for this topic. Move around the room to facilitate discussion and help as needed.

3. Ask groups to share their responses and explain their answers. Encourage them to provide input and feedback on each other's responses.

4. Explain that they will discover the correct information as they discuss **5.3 Key Facts** as a class.

Guided Practice Activity

1. Read through **5.3 Key Facts** as a class, pausing after each one to ask questions and make sure the trainees understand the content.

2. To aid their understanding, show the trainees the following videos that build on **5.3 Key Facts**:

a. https://www.youtube.com/watch?v=JjX9Z4aTLoo
YouTube search: Gardening Preparation Tips: How to Sterilize a House Plant's Potting Soil

b. https://www.youtube.com/watch?v=fUOfQQVubz0
YouTube search: How to Sterilize Soil in The Garden: Grow Guru

3. Now, explain that for the next activity, trainees must write responses individually. Refer them to the following prompts from **Topic 5.3 Task 3:**

Based on your experience, the videos shown to you, and the information in **5.3 Key Facts**, what do you think is the most realistic and resourceful way for you to sterilize soil

here in Rwanda? Provide in your written answer in at least 3-5 sentences. Support your answer with reasons and evidence from **5.3 Key Facts**.

4. Provide your own written response as a sample.

5. Move around the room and help facilitate ideas. Refer trainees to **5.3 Key Facts** for evidence.

6. When they are finished, ask trainees to give their written response to another trainee to read and verify that they answered the questions completely and accurately.

7. Ask trainees to share their responses with the class.

8. Provide observations and feedback as needed.

Application Activity

1. Direct trainees to form groups of three and read the scenario and task from **Topic 5.3 Task 4:**

   Jackson is a student who lives in an apartment in Kigali. He has some tomato seeds that he wants to grow in pots on his roof top. He dug some soil from a nearby field, put it in a bag, and wants to use it for his tomatoes. He knows that you are studying growing mediums, so he asked you to help him.

   Jackson is a student, so he does not have a lot of money for Cash-power. His kitchen does have a microwave. He is permitted to have potted plants on his rooftop.

   a. Provide your recommendation to Jackson on how he can sterilize his soil so that his tomato seeds have an excellent growing medium.

   b. Consider all of the information about Jackson provided.

2. Direct the trainees to think hard about the advice they offer Jackson. Move around the room and discuss the different options with each group. For example, you might ask, "Why do you think he should choose solar/chemical/microwave?"

3. Ask each group to share their answer. Encourage other groups to challenge each other by agreeing or disagreeing.

4. Provide your observations and feedback as well as a sample answer of your own (see below).

Possible Answer:
Jackson could either use a microwave, steam, or solar sterilization. Microwave sterilization may not be an option because it would make his cash-power more expensive. Steam could work if he has pots and either a gas stove or charcoal, but it would be more work. Solar sterilization could work because he would just need to purchase a clear plastic sheet. He could use his roof top where there would likely be direct sunlight and heat (since Kigali is often hot). For solar sterilization, Jackson would just need time because according to **5.3 Key Facts**, you should let the soil heat under the plastic for four weeks.

Points to Remember

- Environmental protection is an important factor when treating soil for a growing medium.

Formative Assessment

Explain to the trainees that the following assessment is to be done individually:

1. Explain the difference between sterilization using an oven and sterilization using a microwave.

2. What is a benefit of chemical sterilization?

3. Which of the following is NOT a step in the solar sterilization process?
   a. Clear the area of plants and debris.
   b. Use a reflective mirror to make the sunlight stronger.
   c. Water the soil until it is wet.
   d. None of the above.

4. What are the three methods of soil sterilization?

Answers:

1. Refer to **5.3 Key Facts**.
2. Answer should include information from the following: These chemicals are selective in nature. They only affect the particular diseases/weed/insects for which they are meant, without causing harm to the other organism that inhabit the soil.
3. a: Use a reflective mirror to make the sunlight stronger.
4. Using steam, using direct heat (with an oven, microwave, or sunlight), and using chemicals.

Self-Reflection

1. Ask trainees to re-take the self-assessment at the beginning of the unit. They should then fill in the table in the Trainee Manual to identify their areas of strength, areas for improvement and actions to take to improve.

2. Discuss trainees' results with them. Identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Learning Unit 6: Assist in setting up growing medium for planting in greenhouse

Learning Outcomes

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

6.1 Identify materials of growing medium

6.2 Prepare growing medium

6.3 Place sterilized soil and amendment in growing medium

Learning Unit 6 Self-Assessment

1. Ask trainees to look at the illustration above (in their Trainee Manuals) and discuss what they see. What topics do they think this unit will include based on the picture? After some brainstorming, share the main topics.

2. Ask trainees to fill out the self-assessment at the beginning of the unit in their Trainee Manuals. Explain that the purpose of the self-assessment is to become familiar with the topics in the unit and for them to see what they know or do not know at the beginning. At the end of the unit, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas that need improvement and actions to take. The self-assessment is not a test!

Learning Outcome 6.1: Identify materials of growing medium

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

a. Explain the characteristics of materials for growing mediums
b. Differentiate the material for growing mediums
c. Select the materials for growing mediums
d. Characterize the materials for growing medium

Time Required: 2 hours

Learning Methodology: Large and small group discussion and brainstorm, peer-to-peer learning tasks, written response, practical exercises

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, pens
- **Reference materials –** internet, computer, reference books, downloaded videos
- **Audio/visual equipment –** projector, speakers
- **Growing medium materials** - boxes and plastic cups, manure, compost, inorganic fertilizers, sand, peat moss, clay, coir, water, pearlite, vermiculite, potting soil mixes; labels on each material

Preparation:

❑ Obtain, prepare, and label all growing medium ingredients for trainees to identify and select (Task 3).
❑ Obtain and prepare small container/cups for trainees to have samples of each ingredient.
❑ Download and preview the following video:
- https://www.youtube.com/watch?v=Tf9jI7mcmcA

YouTube search: CIB – Mixing Your Own Growing Media
❑ Obtain and prepare projector and speakers to show video to trainees.

Cross Cutting Issues:

✓ **Standardization culture:** Learn and practice proper terminology and best practices when identifying and selecting ingredients for growing mediums.
✓ **Environmental sustainability:** Discuss the ingredients and benefits of compos for use as a growing medium.

Prerequisites:

- Crop nutrients
- Soil properties

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain the characteristics of the materials for growing mediums	**1.** Characterize the material for growing mediums	**1.** Collaborative
2. State the ingredients for growing mediums	**2.** Select the material for growing mediums	**2.** Analytical
3. State the characteristics of materials for growing mediums	**3.** Differentiate the material for growing mediums	**3.** Decisive

Steps:

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

1. Facilitate a class discussion. Refer to the points from **Topic 6.1 Task 1** in the Trainee Manuals:

a. Think about the materials used by farmers when preparing organic growing medium.

b. Why are these criteria taken into consideration when selecting the material for growing medium?

2. As the trainees are talking to one another, ask them to share their ideas and answers while you write them on the board. Explain that this topic is partly a review and builds on previous knowledge, specifically from **Topic 5.1** in their Trainee Manuals.

3. Introduce the learning outcome and the Key Competencies table, which includes the knowledge, skills, and attitudes they will gain. Explain that in this topic, they will continue to discuss identifying the materials for growing mediums.

Problem Solving Activity

1. Tell the trainees to work with a partner for **Topic 6.1 Task 2**. With their partners, tell trainees to read and discuss the following information and questions:

   Growing medium ensures that the plant can grow healthily by providing the soil with a range of essential elements, including an optimum rooting environment for physical stability, storage of air for the roots, water absorption and retention, and a supply of nutrients for the roots.

   a. What are the ingredients in growing mediums?

   b. What are the three basic types of growing media and their functions?

2. As the trainees work together, encourage them to refer to **Topic 5.1** to activate their previous knowledge. Move around to each group to help.

3. Ask groups to share their answers with the class. Encourage them to agree and disagree with each other and explain why.

4. Explain that the correct answers will be discussed in **6.1 Key Facts** and they will be given an opportunity to revise their answers from this task.

Guided Practice Activity

Prepare various ingredients in small cups. Be sure there is enough for each pair/team of trainees.

1. Read through **6.1 Key Facts**, pausing after each one to ask questions and make sure the trainees understand the content. As you discuss **6.1 Key Facts**, ask trainees to revise their answers from **Task 2.** Ask them to share the correct answers with you to ensure that they participate and pay attention.

2. To reinforce their understanding, show them the following video that builds on what they read and discussed in **6.1 Key Facts**:

- https://www.youtube.com/watch?v=Tf9jI7mcmcA

YouTube search: CIB – Mixing Your Own Growing Media

3. For the next activity, tell the trainees to work with partners. Refer them to **Topic 6.1 Task 3** and instruct them to complete the task:

   With the materials available in the classroom, identify and select the ingredients for a growing medium that is ideal for young fruit trees. Fruit trees grow best in well-drained soil with a sandy, loamy* texture. They also need deep soil to support their deep root systems.

   * Loam soil is a mixture of soil that is the ideal plant-growing medium. It is actually a combination soil: equal parts of clay, silt, and sand, which gives the benefits of each without the disadvantages.

4. Provide time for the trainees to talk with each other and then make their selections.

5. After the partners are back at their tables/desks, ask each pair to share what they selected and why those ingredients are a good choice as a growing medium for young fruit trees.

6. Offer advice and support where needed and model your own thought process in selecting ingredients so that the trainees can see your expertise and learn best practices/standards.

Answers to Question 3:
Refer to **6.1 Key Facts**.

Application Activity

1. For this activity, inform trainees that they will work individually. Explain that **Topic 6.1 Task 4** will be similar to the previous task, but it will require them to express their ideas in writing.

2. Instruct the trainees to read the following scenario and complete the task from **Topic 6.1 Task 4** in their manuals:

The school wants to you to select the ingredients they would need a growing media to be used for the following purposes:

- To be used to grow young trees and shrubs
- Plants with high water needs
- Good drainage of water
- Provides physical stability for the plants

Write a list of the ingredients that the school should select to meet the above requirements. Explain your reasoning.

3. Prepare your own written response to share to help them learn best practices and standards.

4. Move around the room and facilitate ideas. Refer trainees to **6.1 Key Facts** for evidence.

5. When they are finished, ask them to exchange their written response with another trainee to read and verify that they completed the task accurately.

6. Ask trainees to share their responses out loud with the class.

7. Provide observations and feedback as needed.

Points to Remember

- The three major types of growing media are soil, soilless, and hydroponic.

Formative Assessment

1. List five ingredients in growing media:

1.
2.
3.
4.
5.

2. What are the functions of growing media?

3. What is a benefit of using clay as an ingredient in a growing medium?

4. What are the ingredients to making compost?

Answers:

1. Refer to **6.1 Key Facts**
2. Must provide air, water, nutrient, and support.
3. Refer to **6.1 Key Facts**
4. Refer to **6.1 Key Facts**

ⓘ Further Information for the Trainer

1. CIB - Mixing Your Own Growing Media. (2010, November 26). Retrieved December 16, 2019, from https://www.youtube.com/watch?v=Tf9jI7mcmcA.
2. Growing Media: Ornamental Production. (n.d.). Retrieved December 16, 2019, from https://aggie-horticulture.tamu.edu/ornamental/greenhouse-management/growing-media/.
3. Prasenjit. (2019, November 11). 5 Soilless Mediums That are Best For Growing Vegetables. Retrieved December 16, 2019, from https://gardening-abc.com/soilless-medums-for-growing-plants/.
4. Systems, H. H. (n.d.). Growing Mediums. Retrieved December 16, 2019, from http://www.homehydrosystems.com/mediums/mediums_page.html.
5. What is Growing Media? - Definition from MaximumYield. (n.d.). Retrieved December 16, 2019, from https://www.maximumyield.com/definition/2085/growing-media.

Learning Outcome 6.2: Prepare growing medium

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

a. Select growing media constituents
b. Prepare growing media
c. Characterize growing media

Time Required: 2 hours

Learning Methodology: Large and small group discussion and brainstorm, peer-to-peer learning tasks, inquiry-based written response, multimedia viewing and discussion, practical exercises on preparing a growing medium

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, pens
- **Reference and audio/visual materials –** internet, computer, reference books, downloaded videos, projector, speakers
- **Growing medium materials -** boxes and plastic cups, manure, compost, inorganic fertilizers, sand, peat moss, clay, coir, water, pearlite, vermiculite, potting soil mixes, hoes, shovels, rakes, wheelbarrow, watering cans, supply of water, thermometers, labels

Preparation:

- ❑ Obtain, prepare, and label all ingredients for growing mediums for trainees to identify and select (Task 3).
- ❑ See if the compost piles from **Topic 5.1** are still available.
- ❑ Read and review all tasks and assessments in advance.
- ❑ Download and preview the following videos:
  - https://www.youtube.com/watch?v=E2TY57-uyME
    YouTube search: Potting mix vs Potting soil – EX & Cheap DIY Potting Mix Recipe
  - https://www.youtube.com/watch?v=x4JssQPTYF8
    YouTube search: How to Make Hot Compost Complete Guide

Cross Cutting Issues:

- ✓ **Standardization culture:** Discuss and practice proper terminology and best practices when preparing a growing medium.
- ✓ **Environmental sustainability:** Practice preparing and maintaining their compost piles from Topic 5.1.

Prerequisites:

- ▸ Identifying growing mediums

Key Competencies:

Knowledge	Skills	Attitudes
1. List growing media constituents	**1.** Select growing media constituents	**1.** Detail-oriented
2. State growing media preparation rules	**2.** Prepare growing medium	**2.** Analytical
3. Explain the characteristics of a well-prepared growing medium	**3.** Characterize growing media	**3.** Precise

Steps:

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

1. Facilitate a class discussion by referring to the question from **Topic 6.2 Task 1:**

a. What should you consider when preparing growing media?

b. Why should growing mediums have different constituents/ingredients?

2. As the trainees discuss, ask them to share their ideas and answers while you write them on the board. Explain that this topic is partly a review and also builds on previous knowledge.

3. Introduce the learning outcome and the Key Competencies table, which includes the knowledge, skills, and attitudes they will acquire by the end of this topic.

Problem Solving Activity

1. Tell the trainees to discuss the following question with a partner, found in **Topic 6.2 Task 2** in their manuals:

a. When preparing a growing medium one should follow different rules so that the prepared growing medium is consistent and provides good health to the crop to be grown.

b. Based on what you know now, what do you think some of the rules are to be followed?

c. What do you think are the characteristics of a well prepared growing medium?

2. As the trainees work together, encourage them to refer to their notes and other topics to activate their previous knowledge. Move around to help each group.

3. Ask groups to share their answers with the class. Encourage them to agree and disagree with each other and explain why.

4. Explain that the correct answers will be discussed in **6.2 Key Facts** and that they will be given an opportunity later on to revise their answers from this task.

Guided Practice Activity

Download the video and arrange the computer, projector, and speakers in advance. Prepare the composting tools and equipment in advance.

1. Read through all of **6.2 Key Facts,** pausing after each one to ask questions and make sure the trainees understand the content. As you discuss **6.2 Key Facts**, tell trainees to revise their answers from **Task 2.** Ask them to share the correct answers with you to ensure they participate and pay attention.

2. Next, divide the trainees into groups of three and refer them **Topic 6.2 Task 3** in their manuals. Explain that they should carefully view the video and answer the following questions with their groups:

Video: https://www.youtube.com/watch?v=E2TY57-uyME
YouTube search, Potting mix vs Potting soil – EX & Cheap DIY Potting Mix Recipe

a. What rules for preparing a growing medium did the gentleman in the video follow?

b. Did the potting mix in the video contain soil or was it soilless?

c. What are the benefits of creating a potting mix such as the one shown in the video?

3. Play the video more than once so that the trainees are able to fully understand and answer the questions.

4. Ask the groups to share their answers. Encourage them use evidence from **6.2 Key Facts** as well as the video to support their responses.

5. Next, show them the video they previously viewed from **Topic 5.1** for further review:

Video: https://www.youtube.com/watch?v=x4JssQPTYF8
YouTube search: How to Make Hot Compost Complete Guide

6. Now, take the trainees outside to maintain their compost piles that they started in **Topic 5.1.** Ask the trainees to tell you why they are maintaining their compost piles and what rules they should follow to prepare a growing medium.

Answers to Question 2:

1. The gentleman in the video followed all recommended rules.
2. It was a soilless potting mix.
3. It is cheap and gives good results.

Application Activity

1. For this task, tell the trainees to work with a partner sitting next to them. Refer them to the scenario and questions found in **Topic 6.2 Task 4:**

The school has different constituents/materials to be used for preparation of growing media for growing flowers.

a. What are the rules to be followed?

b. What are the characteristics of a well prepared growing medium?

2. As the trainees discuss, inform them that they should write their answers as well. Move around to observe and help as they write their answers.

3. Ask partners to share their responses and explanations out loud with the class. Encourage others to ask questions and provide feedback.

4. Provide your own feedback and observations as needed.

Answers to Question 1:
Refer to **6.2 Key Facts**

Points to Remember

- When preparing growing media, always remember to make sure that you have the correct ingredients and that you are mixing the correct amount of ingredients together.
- Always consider the crop requirements and the soil properties before you prepare growing medium.
- A well-prepared growing medium will have an optimum rooting environment for physical stability, storage of air for the roots, water absorption and retention, and a supply of nutrients for the roots.

Formative Assessment

Explain that the following assessment is to be done individually.

1. Identify each statement as either **true** or **false**:

   a. A good growing medium should drain well.

   b. A good growing medium should not have the ability to hold nutrients and moisture, even in the heat.

   c. Coconut coir is a good base for potting soil.

2. List three rules to follow when preparing growing media and explain why they are important.

1.
2.
3.

3. List five constituents/ingredients of growing media.

1.
2.
3.
4.
5.

Answers:

1. a. True, b. False, c. True

2. Refer to **6.2 Key Facts**

3. Refer to **6.2 Key Facts**

ⓘ Further Information for the Trainer

1. Australian National Botanic Gardens. Horticulture - Growing media. (n.d.). Retrieved December 16, 2019, from https://www.anbg.gov.au/gardens/living/horticulture/growing.html.

2. Duffy , R. (2013). Good Agricultural Practices for greenhouse vegetable crops. *FAO PLANT PRODUCTION AND PROTECTION PAPER , 217*. Retrieved from http://www.fao.org/3/a-i3284e.pdf

3. Potting mix vs Potting soil - EZ & Cheap DIY Potting Mix Recipe. (2017, October 22). Retrieved December 16, 2019, from https://www.youtube.com/watch?v=E2TY57-uyME.

Learning Outcome 6.3: Place sterilized soil and amendments in growing medium

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

a. Follow guidelines for mixing growing media

b. Follow mixing ratios for growing media preparation

c. Characterize mixed growing media

Time Required: 2 hours

Learning Methodology: Large and small group discussion and brainstorm, peer-to-peer learning tasks, inquiry-based written response, multimedia viewing and discussion, practical exercises on preparing a growing medium.

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, pens
- **Reference and audio/visual materials -** internet, computer, reference books, downloaded videos, projector, speakers
- **Growing medium materials -** boxes and plastic cups, field soil, manure, mature compost, inorganic fertilizers, sand, peat moss, clay, coir, water, pearlite, vermiculite, potting soil mixes, hoes, shovels, rakes, wheelbarrow, watering cans, supply of water, tomato seeds/plants, labels

Preparation:

- ❑ Obtain and prepare all growing medium materials and other equipment.
- ❑ Read and review all tasks and assessments in advance.
- ❑ Obtain tomato seed/plants, if possible, for Task 4.

Cross Cutting Issues:

- ✓ **Gender and inclusivity:** Consider gender balance while forming groups.
- ✓ **Standardization culture:** Discuss and practice proper terminology and best practices when applying soil and amendments in growing media.

Prerequisites:

- Identifying growing mediums
- Crop nutrients
- Soil properties

Key Competencies:

Knowledge	Skills	Attitudes
1. List guidelines for mixing growing medium	**1.** Follow guidelines for mixing growing medium	**1.** Accurate
2. State mixing ratios for growing media preparation	**2.** Follow mixing ratios for growing media preparation	**2.** Analytical
3. Explain the characteristics of a well-mixed growing media	**3.** Characterize mixed growing media	**3.** Detail-oriented

Steps:

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

1. Facilitate a class discussion using the questions found in **Topic 6.3 Task 1** in the Trainee Manuals:

   a. What are soil amendments?

   b. What are growing mediums?

   c. How are they related?

2. As the trainees discuss, ask them to share their ideas and answers while you write them on the board. Explain that this topic is partly a review and builds on previous knowledge.

3. Introduce the learning outcome and the Key Competencies table, which includes the knowledge, skills, and attitudes they will acquire by the end of this topic.

Problem Solving Activity

1. Ask the trainees to work with a partner for **Topic 6.3 Task 2**. Tell them to read the following scenario and discuss the questions:

   Kalisa and Gahire work at a company that prepares bagged growing mediums. Recently, customers have complained that their growing mediums do not have any air circulation or water filtration.

   a. What do you think caused poor air circulation and water filtration in the growing mediums?

   b. Advise Kalisa and Gahire on how to produce quality growing mediums for their customers.

2. As the trainees work together, encourage them to refer to their notes and other topics to activate their previous knowledge. Move around to each group to help.

3. Ask groups to share their answers with the class. Encourage them to agree and disagree with each other and explain why.

4. Explain that the correct answers will be discussed in **6.3 Key Facts** and they will be given an opportunity to revise their answers from this task later.

Guided Practice Activity

Gather and arrange all growing mediums and soil amendment materials to mix in the classroom in advance. Provide containers and plastic cups for trainees to work with in their space.

1. Read through all of **6.3 Key Facts**, pausing after each one to ask questions and make sure the trainees understand the content. As you discuss **6.3 Key Facts**, ask trainees to revise their answers from **Task 2.** Ask them to share the correct answers with you to ensure they participate and pay attention.

2. Now, ask the trainees to form groups of three and refer to the scenario and tasks from **Topic 6.3 Task 3:**

You are requested to mix growing media using different constituents available in the school workshop. The mixing ratio to follow is 1:1:1 mature compost, field soil, and field sharp sand or perlite.

Using the mixing guidelines for growing media, you are requested to follow the mixing ratio to avoid overmixing and to meet the characteristics of a well-mixed growing media.

3. Demonstrate how to complete this activity. Model mixing and thinking out loud about the consistency of the growing medium and what characteristics it should have after being well-prepared.

4. Then, instruct the groups to complete the task by mixing the growing medium in a bucket/container within their space.

5. Walk around to check the trainees' participation and work-ethic. Ask them questions to make sure they understand and perform the task correctly.

6. Ask trainees to share their thoughts and ideas as well as challenges from this activity.

Answers: Refer to **6.3 Key Facts**

Application Activity

1. Either have all the materials and supplies in the classroom or take the trainees to an area that can accommodate this task.

2. Divide the trainees into pairs and read **Topic 6.3 Task 4** as a class:

   You are requested to mix growing media constituents for tomato plants. The mixing ratio to follow is 1:2:1 mature compost, field soil, and field sharp sand or perlite.

   Using the guidelines, mix the growing media with all the characteristics as required by your crop.

3. Provide trainees with the following information about tomato crops:

a. Soil Types and Textures

Loam and sandy loam soils are best for tomato production, but tomatoes will grow in almost all soil types, except heavy clay. If you your soil has lots of clay, you can improve the texture by tilling the soil and incorporating sand, sawdust, peat moss or other amendments before planting. The soil should be loose and well-drained. Tomatoes don't do well in dry soil, but avoid planting them in excessively wet, waterlogged soil, or anywhere standing water gathers after a rain.

b. Soil pH Level

A soil's acidity or alkalinity is measured by its pH level. A pH of 7 is considered neutral, while anything lower is acidic and anything higher is alkaline. Tomatoes grow best in neutral or near-neutral soil, so you may have to modify your soil's pH for best results. If necessary, you can raise pH by incorporating ground agricultural lime into the soil before planting. You can lower pH by adding elemental sulphur or fertilizers that contain ammonium sulphate.

c. Fertility

Tomatoes grow well in moderately fertile soil with lots of organic matter. You can incorporate compost when you prepare the soil. Adding an all-purpose fertilizer containing potassium and phosphorous can also be helpful. Avoid fertilizers with high nitrogen content, because these can result in bushy plants that produce little fruit.

d. Note

A good starting point is to have your soil tested. The results of the soil test will reveal nutrient content and pH, as well as make recommendations for soil amendments.

4. As the trainees read the crop requirements, select materials, and verify the guidelines using evidence from **6.3 Key Facts**, walk around to offer support and give suggestions and observe their application.

5. When trainees are finished, ask each group to share their process. Instruct others to listen carefully and offer support/suggestions.

6. After the teams have presented their mixing processes and explained them with evidence from the text, provide your observations and any additional feedback and support.

Points to Remember

- While mixing your own media, thoroughly mix components, but do not over-mix, especially if a media contains vermiculite or a controlled release fertilizer.

Formative Assessment

1. Identify each statement as either **true** or **false**:

a. Clay is frequently used for plants with high water needs because it can store the water longer.

b. Perlite is a material used to break up the soil and enhance air circulation.

c. It is acceptable to make changes to the medium before experimenting with it first.

d. Fill growing containers with soil lightly and avoid compaction.

2. Explain why it is important to both sterilize the soil and place amendments.

Answers:

1. a. True, b. True, c. False, d. True

2. Refer to **6.3 Key Facts**

Self-Reflection

1. Ask trainees to re-take the self-assessment at the beginning of the unit. They should then fill in the table in the Trainee Manual to identify their areas of strength, areas for improvement and actions to take to improve.

2. Discuss trainees' results with them. Identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Learning Unit 7: Assist in sterilizing soil for organic growing medium

Learning Outcomes

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

7.1 Identify materials, tools, and equipment for installing watering system

7.2 Install water supply system

7.3 Water according to the crop water requirements

Learning Unit 7 Self-Assessment

1. Ask trainees to look at the illustration above (in their Trainee Manuals) and discuss what they see. What topics do they think this unit will include based on the picture? After some brainstorming, share the main topics.

2. Ask trainees to fill out the self-assessment at the beginning of the unit in their Trainee Manuals. Explain that the purpose of the self-assessment is to become familiar with the topics in the unit and for them to see what they know or do not know at the beginning. At the end of the unit, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas that need improvement and actions to take. The self-assessment is not a test!

Learning Outcome 7.1: Identify materials, tools, and equipment for installing watering system

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

a. Identify the selection criteria of tools and equipment for installing an irrigation system

b. Select tools for installing an irrigation system

c. Select equipment for an irrigation system

Time Required: 2 hours

Learning Methodology: Large and small group discussion and brainstorm, peer-to-peer learning tasks, small group tasks, inquiry-based written response, multimedia viewing and discussion, field visit to apply classroom content

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, pens
- **Reference and audio/visual materials -** internet, computer, reference books, downloaded videos, projector, speakers

Preparation:

❑ Download and preview the following video:
- https://www.youtube.com/watch?v=amrCMakolKA
  YouTube search: What is Irrigation?

❑ Prepare computer, projector, and speakers for the video.

❑ Preview all tasks and assessment questions in advance.

❑ Contact a farm to visit with a functioning irrigation system that the trainees can observe.

Cross Cutting Issues:

✓ **Gender and inclusivity:** Consider gender balance while forming groups.

✓ **Standardization culture:** Discuss and practice proper terminology and best practices when identifying tools and equipment for watering systems.

✓ **Environmental sustainability**: Emphasize rainfall capture and responsible usage of water for irrigation.

Prerequisites:

- Agricultural tools, materials, and equipment
- Crop water requirements

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain the selection criteria of tools and equipment for installing an irrigation system	**1.** Characterize tools and equipment for installing an irrigation system	**1.** Team spirit
2. List tools for installing an irrigation system	**2.** Select tools for installing an irrigation system	**2.** Analytical
3. State the characteristics of an irrigation site	**3.** Characterize the site for irrigation	**3.** Honest

Steps:

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

1. Facilitate a class discussion using the questions found in **Topic 7.1 Task 1** in the Trainee Manuals:

a. How does a farmer maintain her crops in the dry season?

b. What different ways to water crops have you seen/experienced?

c. What are some of the tools you have used or seen when watering crops?

2. As the trainees discuss, ask them to share their ideas and answers while you write them on the board.

3. Introduce the learning outcomes and the Key Competencies table, including the knowledge, skills, and attitudes they will acquire by the end of this topic.

Problem Solving Activity

1. Ask trainees to form groups of three and refer to **Topic 7.1 Task 2** in their manuals.

2. Using what they already know, tell trainees to properly identify some of the tools and make educated guesses about the others.
3. As they work, walk around the classroom to facilitate discussion about what they think the tools and equipment are used for.

4. Ask groups to share their answers for pictures A – K. Encourage others to agree or disagree and state why.

5. Provide your observations and feedback.

Answers:

A. Hack saw
B. Wire cutters
C. Wrench
D. Knife
E. Shovel
F. Mattock/pickaxe
G. Pipe wrench
H. Pry bar
I. Trenching shovel
J. Garden hose
K. PVC pipes

Guided Practice Activity

1. Read through all of **7.1 Key Facts**, pausing after each one to ask questions and make sure the trainees understand the content. As you discuss **7.1 Key Facts**, ask trainees to refer to the pictures in **Task 2** and verify that they have the correct names for the tools and equipment. Ask them to share the correct answers with you to ensure they participate and pay attention.

2. As an extra resource to help the trainees better understand the content, show them the following video:

   - https://www.youtube.com/watch?v=amrCMakolKA
     YouTube search: What is Irrigation?

3. Now, tell the trainees to find a partner and refer to **Topic 7.1 Task 2** in their manuals. Tell them to read the following scenario and answer the questions with their partners:

   Munyanziza and Munyemana are farmers growing vegetables. They want to continue planting in the dry season, but they are worried they will not have enough water for their crops. They would like to buy tools and equipment to install an irrigation system on their farm so they can supply water to their crops during the dry season.

   a. Name the tools and equipment needed to install a basic irrigation system on their land.

   b. What are the criteria to consider when selecting tools and equipment for irrigation?

4. As the trainees discuss their answers, walk around the room and offer help as needed.

5. Ask each group to share their answers. Encourage others to ask questions and provide feedback.

6. Provide your own observations and feedback as needed.

Answers to Question 3:
Refer to **7.1 Key Facts**

Application Activity

1. Take the trainees to a farm to visit and observe a watering system in action. Introduce them to the farmer and any workers present.

2. Inform trainees that they should choose a partner for this activity. Refer to the instructions found in **Topic 7.1 Task 4:**

   You are visiting a farm with functioning watering systems. As you tour the farm, discuss and answer the following questions:

   a. Make a list of the tools and equipment you see for the water supply system.

   b. What are their purposes?

c. Ask the farmer: How did he/she select the equipment and types of watering system? What were the criteria he/she considered?

3. As the trainees observe the watering systems on the farm, facilitate a discussion between the trainees and the farmer about the watering system. Encourage trainees to ask any questions they still have about watering/irrigation systems.

4. Bring everyone together to share their findings.

5. As the trainees present their answers, encourage others to ask questions and provide feedback.

6. Provide your own observations and feedback.

Points to Remember

- A basic watering system requires a shovel, hacksaw, wire cutter, a couple of wrenches, knife, hose, and water tank.

Formative Assessment

Explain to the trainees that the following assessment is to be done individually.

1. Identify the following statements as either **true** or **false**:

a. Any tool can be used for installing an irrigation system.

b. Different irrigation methods have different tools and equipment.

c. When selecting tools and equipment, remember the type of irrigation method to be used.

2. List the tools and equipment for capturing rainfall into a tank.

3. What is the purpose of a flow control device?

Answers:

1. a. False
b. True
c. True

2. Refer to **7.1 Key Facts**. Answer should include: tank, gutters, pipe.

3. To control the amount of water being dispersed/let out.

Further Information for the Trainer

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3. What Is Irrigation? (2013, April 29). Retrieved December 17, 2019, from https://www.youtube.com/watch?v=amrCMakolKA.

Learning Outcome 7.2: Install water supply system

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

a. Identify methods of irrigation
b. Choose an irrigation method
c. Install water supply system

Time Required: 2 hours

Learning Methodology: Large and small group discussion and brainstorm, peer-to-peer learning tasks, small group tasks, inquiry-based written response, multimedia viewing and discussion, real-world problem-solving using domain specific content

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, pens
- **Reference materials -** internet, computer, reference books
- **Audio/visual materials -** downloaded videos, projector, speakers

Preparation:

❑ Download and preview the following videos to show the trainees:
- https://www.youtube.com/watch?v=tmEj3MQPlTY
  YouTube search: Drip Irrigation Basics
- https://www.youtube.com/watch?v=mzD6eH4fmIw
  YouTube search: Overhead Sprinkler Irrigation
- https://www.youtube.com/watch?v=rZzG_Mfhicg
  YouTube search: Using Rain Barrels to Irrigate Your Garden

❑ Prepare computer, projector, and speakers for the video.
❑ Preview all tasks and assessment questions in advance.

Cross Cutting Issues:

✓ **Gender and inclusivity:** Consider gender balance while forming groups.
✓ **Standardization culture:** Discuss and practice proper terminology and best practices when installing watering systems.
✓ **Environmental sustainability**: Emphasize rainfall capture and responsible usage of water for irrigation.

Prerequisites:

- Watering system tools and equipment

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain types of irrigation methods	**1.** Characterize different irrigation methods	**1.** Collaborative
2. List the criteria for choosing an irrigation method	**2.** Choose an irrigation method	**2.** Analytical
3. List the irrigation components	**3.** Install a water supply system	**3.** Determined

Steps:

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

1. Facilitate a class discussion by referring to the question from **Topic 7.2 Task 1:**

Think about the irrigation and watering systems you have seen.

a. What are their components?

b. What methods have you seen or experienced?

2. As the trainees discuss, ask them to share their ideas and answers while you write them on the board.

3. Introduce the learning outcome and the Key Competencies table, including the knowledge, skills, and attitudes they will acquire by the end of this topic.

Problem Solving Activity

1. Tell the trainees to work with a partner to complete **Topic 7.2 Task 2** in their manuals:

An adequate water supply is important for plant growth. When rainfall is not sufficient, the crops must receive additional water from irrigation.

a. What criteria should you consider when choosing any irrigation method?

2. As the trainees work together, encourage them to refer to their notes and other topics to activate their previous knowledge. Move around to help each group.

3. Ask groups to share their answers with the class. Encourage them to agree and disagree with each other and explain why.

4. Explain that the correct answers will be discussed in **7.2 Key Facts** and they will be given an opportunity later on to revise their answers from this task.

Guided Practice Activity

1. Read through **7.2 Key Facts**, pausing after each one to ask questions and make sure the trainees understand the content. As you discuss **7.2 Key Facts**, ask trainees to revise their answers from **Task 2**. Tell them to share the correct answers with you to make sure they participate and pay attention.

2. As an extra resource to help the trainees better understand the content, show them the following videos:

- https://www.youtube.com/watch?v=tmEj3MQPlTY
  YouTube search: Drip Irrigation Basics

- https://www.youtube.com/watch?v=mzD6eH4fmIw
  YouTube search: Overhead Sprinkler Irrigation

- https://www.youtube.com/watch?v=rZzG_Mfhicg
  YouTube search: Using Rain Barrels to Irrigate Your Garden

3. Now, tell the trainees to work in pairs and refer to **Topic 7.2 Task 3:**

a. Based on the illustrations, **7.2 Key Facts**, and the videos: What are the advantages and disadvantages of the sprinkler, drip, and surface/channel irrigation methods?

b. Make a list and be prepared to support your reasons with evidence.

4. Explain that for this activity, the information is not directly stated in their manuals or the videos. They must make inferences (educated guesses based on evidence) from the resources provided and use their experience.

5. Move around the room to help facilitate discussion and ask guiding questions. For example, “Would a system that relies on a pump and electricity be a challenge for a rural farmer? Why or why not?”

6. Ask trainees to share their lists of advantages and disadvantages for each system. Make notes of their reasons on the board for the class to see. Encourage them to agree or disagree with each other and state why.

7. Provide your observations and feedback.

Answers to Question 3:
Refer to the videos and **7.2 Key Facts**.

Application Activity

1. First, divide the trainees into pairs and read **Topic 7.2 Task 4** to the trainees:

   A farmer would like to grow tomatoes in a greenhouse like the one shown below. You are requested to assist in the installation of a watering system.

[1]

[1] User: W.carter. (2017, August 22). *Small greenhouse with grapevines escaping - side view* [Photograph]. Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Small_greenhouse_with_grapevines_escaping_-

2. With their partners, tell trainees to discuss the following questions about the scenario:

   a. What type of irrigation system do you recommend and why?

   b. What tools and equipment will you need to get started?

3. As the trainees discuss and analyse the picture, encourage them to refer to **7.2 Key Facts**. Walk around to offer support, give suggestions, and observe their participation.
4. Inform them that the answers to these questions are not directly stated in **7.2 Key Facts**. They must think critically, combining the information given with their own experience and previous knowledge.

5. When trainees are finished, ask teams to share their answers and to listen carefully to other groups. Encourage them to listen for any mistakes and offer support/suggestions.

6. After everyone has presented their responses, provide your observations and any additional/necessary feedback and support.

Answers to Question 2:
Refer to **7.1 and 7.2 Key Facts**.

a. The space is too small for sprinklers, but a good size for drip irrigation or even manual irrigation using gravity flow from a water tank/cistern.
b. Water tank, watering can, hose, pipe, flow control device, hack saw.

Points to Remember

- Consider the farm scale as well as the costs and benefits when installing a water supply system.

side_view.jpg
Public Domain

Formative Assessment

Explain that the following assessment is to be done individually.

1. Identify each statement as either **true** or **false**:
   a. With drip irrigation, only the immediate root zone of each plant is wetted.
   b. Sprinkler systems do not need a pump.
   c. Surface irrigation using channels can be fed by a gravity system.

2. What are the benefits of a drip system?

3. What are diversion and conveyance structures?

Answers:

1. a. True, b. False, c. True
2. Refer to **7.2 Key Facts**
3. Refer to **7.2 Key Facts**

Further Information for the Trainer

1. DIY Network. (2015, March 16). How to Install a Sprinkler System. Retrieved December 17, 2019, from https://www.diynetwork.com/how-to/outdoors/landscaping/how-to-install-a-sprinkler-system.
2. Drip Irrigation Basics. (2013, November 22). Retrieved December 17, 2019, from https://www.youtube.com/watch?v=tmEj3MQPlTY.
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Learning Outcome 7.3: Watering according to the crop water requirements

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

a. Identify the factors affecting crop water requirement/needs

b. Calculate the irrigation time of crops

c. Identify the environmental and economic benefits of specific irrigation types.

Time Required: 2 hours

Learning Methodology: Large and small group discussion and brainstorm, peer-to-peer learning tasks, small group tasks, reading comprehension with domain specific content & inquiry-based written response, multimedia viewing and discussion, real-world problem-solving

Materials Needed:

- **Standard training materials -** flip chart, markers, black/white board, chalk, tape, A4 paper, pens
- **Reference materials -** internet, computer, reference books
- **Audio/visual materials -** downloaded videos, projector, speakers

Preparation:

❑ Download and preview the following videos to show the trainees:

- https://www.youtube.com/watch?v=5H-QjSuHnxU
  YouTube search: How to Water for Better Tasting Crops

❑ Prepare computer, projector, and speakers for the video. Preview all tasks (reading comprehension articles) and assessment questions in advance

Cross Cutting Issues:

✓ **Gender and inclusivity:** Consider gender role while forming groups.

✓ **Standardization culture:** Discuss and practice proper terminology and best practices when discussing and practicing watering requirements for crops.

✓ **Environmental sustainability**: Emphasize drip irrigation for environmental and economic conservation.

Prerequisites:

- Irrigation methods
- Tools and equipment for installing watering systems
- Soil properties

Key Competencies:

Knowledge	Skills	Attitudes
1. List the factors affecting crop water requirements /needs	**1.** Identify factors affecting crop water requirement/needs	**1.** Accurate
2. State the rules followed for watering crops	**2.** Calculate the irrigation time	**2.** Analytical
3. List the environmental and economic benefits of irrigation techniques	**3.** Choose a watering technique based on environmental and economic benefits	**3.** Conservative

Steps:

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

1. Facilitate a class discussion by referring to **Topic 7.3 Task 1** in the Trainee Manuals. Ask trainees to think about the following situation:

Crops are suffering from insufficient water to the point that if water is not supplied, the crops will dry up and there will be no yield. Some farmers grow paddy rice and beans in a low land area and think that water from a small river passing around the plot is sufficient for both paddy rice and beans without any additional water. After trying this, the paddy rice failed as compared to the beans which gave the targeted yield.

2. Ask trainees: What are the causes of the differences in yield between paddy rice and beans?

3. As the trainees discuss, ask them to share their ideas and answers so you can write them on the board.

4. Introduce the learning outcome and the Key Competencies table, which includes the knowledge, skills, and attitudes they will acquire by the end of this topic.

Problem Solving Activity

1. Ask the trainees to work with a partner for **Topic 7.3 Task 2**. Direct them to complete the following tasks:

   a. Write: A list of what factors you think should be considered when watering crops.

   b. Discuss: What are watering guidelines you should follow with any crop?

2. As the trainees work together, encourage them to look back at their notes and other topics to activate their previous knowledge. Move around to help each group.

3. Ask groups to share their answers with the class. Encourage them to agree and disagree with each other and explain why.

4. Explain that the correct answers will be discussed in **7.3 Key Facts** and they will be given an opportunity later to revise their answers from this task.

Guided Practice Activity

1. Read through **7.3 Key Facts**, pausing after each one to ask questions and make sure the trainees understand the content. As you discuss **7.3 Key Facts**, ask trainees to refer their answers from **Task 2**. Tell them to share the correct answers with you to make sure they participate and pay attention.

2. As an extra resource to help the trainees better understand the content, show them the following video:

   Video: https://www.youtube.com/watch?v=5H-QjSuHnxU
   YouTube search: How to Water for Better Tasting Crops

3. Now, tell the trainees to separate into groups of five people. Refer them to the following information and questions from **Topic 7.3 Task 3** in their manuals:

More than 100 varieties of the potato exist. A potato plant needs soil temperatures of about 15 to 21 degrees Celsius in order for tuber formation to occur. If soil temperatures become too warm, 26 degrees Celsius or warmer, potatoes don't develop.

Irrigation Schedule

Provide enough water to a potato plant so that its soil is moist, but not saturated. The general rule is to provide it 2.5 to 5 cm of water per week, including rain fall. A consistent water schedule of once every four to five days is ideal for a young plant. Increase the frequency to once every two to three days when potatoes form, which happens about the same time the plant flowers, to encourage uniform potatoes. Regular watering also helps keep soil temperatures cooler. Stop watering a potato plant when its leaves turn yellow and start to die back. Stop irrigating a plant once it begins to wilt provides potatoes longer time to cure or dry before they're picked.

Watering Method

Drip irrigation from a garden hose works best for potatoes. Overhead irrigation can injure a young, fragile plant. Furthermore, use of a watering can tends to direct too much water to the top of the plant and too little to its roots where it's needed most. Warm, wet foliage encourages fungal growth and weakens the plant structure.

Considerations

Over-watering a potato plant causes irregular tuber formation, promotes rot and increases risk of disease. Under- watering a plant so that its soil dries out completely prohibits canopy and tuber formation and often leads to irregular potatoes with various imperfections. The effects of poor watering practices results in a stressed plant that takes several days, even after the issue is corrected, for it to overcome.

a. What type of soil conditions are right for potatoes?

b. When and why should you discontinue irrigating the potato plants?

c. Which form of irrigation is ideal (best) for potatoes?

d. What is a result of over-watering potato plants?

e. How often should you water a young potato plant?

4. First, read the article to the class out loud and direct them to listen carefully. Then, inform the trainees that each group member must be responsible for one question.

5. Allow the groups to read and discuss the article and answer the questions as you walk around to help and make sure everyone participates.

6. After the groups have answered the questions, ask each group to present their answers. Challenge them by directing them to support every answer with evidence from the text and be specific.

7. Provide your observations and feedback as needed.

Application Activity

1. For this activity, the trainees will work in groups of two. Refer them to **Topic 7.3 Task 4** in their manuals. Tell them to read the article and questions with their partners and use evidence from the article to support each answer. Encourage them to underline or mark the text where they find the answers or information that can help them.

   Tomatoes are one of the most popular vegetables grown. One of the reasons is that they are relatively easy to grow. But that does not mean that they grow without care. One of the most crucial parts of their care is knowing how much water tomato plants need.

   The number one rule of watering tomatoes is to make sure that you go slow and easy. Never rush watering tomato plants. Use a drip hose or other forms of drip irrigation to deliver water to your tomato plants slowly.

   Water regularly: How often should you water tomato plants? There is no hard and fast rule to this. It depends on how hot it is and if the plant is actively growing. A good rule of thumb is to supply water once every two or three days during the hot and dry season. Remember that water supplied by rainfall counts towards watering tomato plants in the garden. Once the weather cools and fruit has set, scale back watering to once a week.

   Water at the roots: When watering tomatoes, it is normally recommended that you water straight to the roots rather than from above, as this can cause disease and pests to attack the plants. Watering tomato plants from above also encourages premature evaporation and unnecessarily wastes water.

Mulch: Using mulch helps to keep water where the plants need it. Use mulch to slow down evaporation.

a. What is the "number one rule" of watering tomato plants?

b. How can you slow down evaporation and conserve water for your plant's roots?

c. When it is hot and dry, how often should you water tomato plants?

d. What is the recommended irrigation method for tomato plants?

2. While the groups work, walk around the room and offer support and feedback as needed. Demonstrate how to underline and mark the information in the text that will help support their answers.

3. After the partners read and discuss the article and answer the questions, ask the groups to present their answers out loud to the class. Encourage other trainees to challenge them by asking them to identify the evidence for their answers.

4. Provide your observations and feedback as needed.

Points to Remember

- The amount of water a crop needs depends mainly on the climate, the crop type, and the growth stage.

Formative Assessment

Explain to the trainees that the following assessment is to be done individually.

1. Which of the following options do crop-water needs NOT depend on?
- **a.** climate
- **b.** tools available
- **c.** growth stage of the crop
- **d.** crop type
- **e.** size of the water storage tank

2. Explain why water-logging should be avoided.

3. What part of the plant must receive the water?

4. List five of the ten rules of watering.
   1.
   2.
   3.
   4.
   5.

Answers:

1. b & e
2. Refer to **7.3 Key Facts**
3. Refer to **7.3 Key Facts – the roots.**
4. Refer to **7.3 Key Facts**

Self-Reflection

1. Ask trainees to re-take the self-assessment at the beginning of the unit. They should then fill in the table in the Trainee Manual to identify their areas of strength, areas for improvement and actions to take to improve.

2. Discuss trainees' results with them. Identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Summative Assessment

Integrated Situation

TERIMNERE is a seed multiplier cooperative of Irish potatoes in Musanze district in Kinigi sector; it operates seed multiplication activities on the area of 15ha (Kinigi variety) and has some farm facilities such as store, greenhouse and tanks for water supply.

This cooperative has recently obtained a great market of selling 16 T of Irish potato seeds with DERN of Diocese Ruhengeri for their project beneficiaries in rural areas .In the previous season preparation meeting; the cooperative members requested Mr. MURENZI Bernard the president of TERIMBERE cooperative to look for a private soil testing laboratory to test their land soil. The idea came after they had realized that the soil productivity and potato seed production have been hugely decreasing in the last two seasons. Nevertheless, a few members think that the decreasing of potato seed production is the result of poor performing tillage and contamination of growing medium during planting the plantlets but plenty of members suggested the issue of soil infertility and incorrect installation of channels and tubes conducting water from the tanks to the green house.

As requested by the members; the president contacted ENAS Nkubiri Ltd as a private soil testing laboratory which has sent the laboratory technician to take the soil samples for being tested and to help treating the soil used in the green house; however the cooperative president must carefully choose a professional farmer who must assist in collecting and handling soil samples for laboratory testing.

As a skilled professional farmer; you are requested to perform the activities related with growing medium by demonstrating how the following activities will be performed: Assist in collecting soil samples for laboratory testing; Assist in preparing soil samples for laboratory testing, assist in sterilizing soil for growing medium; perform tillage for planting; assist in setting up growing medium for planting; assist in setting up water delivery systems for growing medium.

Irish potato spacing: 30 x 80 cm; yield: 16t/ha
Soil drying oven standard size: SDO/225; Volume: 225 L^3
External dimensions: 94 mm x 109 mm x 57 mm
Internal dimensions: 54 mm x 92 mm x 44 mm

Weight: 80 kg
Field demonstration plot: 16m^2
Variety: Kinigi
Net tunnel (replacing a greenhouse) for demonstration: Length 3 m, Height 1.5 m, Width 2 m for demonstration
Area of demo plot: 9 m^2

You must do the task in 4 hours.
Tools: hand auger, steriliser, container , air-drying, saws, motor, Tanks, tubes, channels, sieve, weight device, Sheeting, sacks, plastic bags , net bags Spades, sieve, Mortar , Trowel, Shovel, Tape measure, Watering can, pipes Water container, Hand auger, basin, ropes

Equipment:
Wheelbarrow, Drying oven, Water tank. Sprayer, PPE, Helmet, Gloves, Goggles, Dust mask Safety shoes (boots)

Assessment Criterion 1: Quality of product

Checklist	Score	
	Yes	No
Indicator 1: Tools and equipment for soil sampling are properly identified		
Identify site		
Prepare tools, material and equipment for sampling		
Indicator 2: Tools and equipment for sampling are properly cleaned		
Decontamination methods		
Sanitizing materials, tools, and equipment for sampling		
Indicator 3: Tools and equipment for soil sampling are properly adjusted		
Adjustment techniques		
Adjustment procedures		
Indicator 4: Soil samples for laboratory testing are properly collected		
Methods of soil samples		
Random soil sampling		
Benchmark soil sampling		
Indicator 5: Soil samples are well handled		
Methods of packaging soil sampling		
Transporting soil sampling		
Drying soil sampling		

Indicator 6: Laboratory soil protocols and procedures are well selected		
Soil reparation protocols		
Soil preparation procedures		
Indicator 7: Soil samples are properly prepared		
Mortaring/sieving soil samples		
weigh soil samples		
dry soil samples		
Indicator 8: Laboratory recommendations results are well applied		
Execution of laboratory Recommendations		
Execution of laboratory Instructions		
Indicator 9: Land for tillage is properly selected		
Field site		
Climate conditions		
Indicator 10: Tools and equipment for tillage are properly identified		
Tools for tillage		
Equipment for tillage		
Indicator11: Types of tillage are properly identified		
primary tillage		
Layout of seed bed		
Second tillage		
Indicator 13: Soil conservation measures are well applied		
Crop rotation		
Fallowing		
Planting agro-forestry trees		
Planting fodder crops		
Performing ditches		
Indicator 14: Amendments are properly selected		
Selection of amendments		
Calculation of amendments		
Indicator 15: Amendments are properly prepared		
Preparation of organic amendments		
Preparation of inorganic amendments		
Indicator 16: Amendments are accurately applied		
Dosage of amendments		
Application of fertilizing methods		
Indicator 17: Soil for growing medium is properly identified		
Identification of soil for growing medium		

Types of growing medium		
Indicator 18: Tools, materials, and equipment for soil sterilization are well identified		
Tools for soil sterilization		
Materials for soil sterilization		
Equipment for soil sterilization		
Indicator 19: Soil is well treated for growing medium		
Methods of soil sterilization		
Sterilization procedures		
Sterilization protocols and instructions		
Sterilization techniques		
Indicator 20: Materials for growing medium are properly identified		
Materials of growing medium		
Preparation of materials of growing medium		
Indicator 21: Growing medium is well prepared		
Weighing soil medium		
Sieving soil for growing medium		
Mortaring soil for growing medium		
Transporting soil medium		
Indicator 22: Treated soil and amendments are properly placed in growing medium		
Transportation of treated soil		
Placement of treated soil		
Application of amendments		
Watering growing medium		
Indicator 23: Materials, tools and equipment for installing watering system are well identified		
Materials for installing watering system		
Tools for installing watering system		
Equipment for installing watering system		
Indicator 24: Water supply system is well installed		
Methods of installing water supply		
Storage tanks and dams		
Channels systems		
Indicator 25: Watering according to the crop water requirements are well performed		
Crop water requirements		
Watering		
Observation		

Assessment Criterion 2: Quality of product

Checklist	Score	
	Yes	No
Indicator 1: Soil samples properly handled		
Soil samples are correctly collected		
Soil samples are properly transported		
Soil samples are properly prepared		
Indicator 2: Water supply system properly installed		
Tubes and channels well-functioning		
Plantlets planted in growing medium are adequately watered		
Indicator 3: Soil for growing medium is properly treated		
Soil correctly sterilized		
Free contaminated growing medium		
Healthily plantlets grown in organic medium		
Indicator 4: Land is properly tilled		
Soil is well softened		
Free stones prepared plot		
Observation		

Assessment Criterion 3: Relevance

Checklist	Score	
	Yes	No
Indicator 1: Time is effectively managed		
Duration: 4hours		
Indicator 2: Plot dimensions are accurately respected		
Area of the plot (16m^2)		
Length (4m)		
Width (4 m)		
Indicator 3: Spacing is accurately respected		
Between rows (80 cm)		
Within rows (30 cm)		
Indicator 4: Drying oven standards size are accurately respected		
Area of the plot (96 m^2)		
Length (12m)		
Volume (225 Litres)		
External dimensions: 94mmx109mmx57mm		
Internal dimensions: 54mmx92mmx44mm		
Weight (80kg)		
Indicator 5: Fertilizer dosage recommended are accurately respected		
NPK: 300kg /Ha		
Manure/compost: 10T/ha		
Indicator 6: Variety is respected		
Irish potato: Kinigi variety		
Indicator 7: Net tunnel dimensions are accurately respected		
Dimensions		
Length: 3 m		
Width: 2 m		
Height: 1.5 m		
Observation		

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