RWANDA POLYTECHNIC

TVET LEVEL II

AGRICULTURE

Horticultural Crop Production

TRAINEE MANUAL

RWANDA POLYTECHNIC

Approved by: Workforce Development Authority

USAID FROM THE AMERICAN PEOPLE

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HORTICULTURAL CROP PRODUCTION

Unit 1: Perform horticultural planting activities

Unit 2: Assist in horticultural crops maintenance

Unit 3: Assist in harvesting activities

Unit 1: Perform horticultural planting activities

Topics

1.1 Preparation of planting materials

1.2 Preparation of planting operations

1.3 Carrying out of planting operations

Unit Summary:

This learning unit will provide the knowledge and skills as well as an understanding of the necessary attitude required to perform horticultural planting activities. At the end of this unit, learners will be able to prepare planting materials, prepare for planting operations, and carry out planting operations.

Self-Assessment: Unit 1

1. Observe the unit illustrations above. What do you see? What do you think this unit will be about?

2. Fill in the self-assessment below.

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

My experience **Knowledge, skills and attitudes**	**I don't have any experience doing this.**	**I know a little about this.**	**I have some experience doing this.**	**I have a lot of experience with this.**	**I am confident in my ability to do this.**
List tools and soils that need to be acquired to prepare for planting					
Select good horticultural planting materials					
Perform horticultural planting materials pre-treatment					
Acquire tools and soils required to prepare for planting					
List planting methods and patterns for horticultural crops					
Apply pre-treatment techniques of planting material					
Perform handling during transportation of seedlings					

Identify planting methods and patterns for horticultural crops					
List immediate care, waste management procedures, and record keeping					
Respect the elements that considered in planting material					
Apply planting techniques					
Apply waste management techniques and record keeping					

Topic 1.1: Prepare planting materials

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe criteria for selecting horticultural planting materials	**1.** Select good horticultural planting materials	**1.** Analytical
2. Describe methods of horticultural planting materials pre-treatment	**2.** Perform horticultural planting materials pre-treatment	**2.** Meticulous
3. List tool and soils that need to be acquired to prepare for planting	**3.** Acquire tools and soils required to prepare for planting	**3.** Careful

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

Topic 1.1 Task 1:

[1]

1. Look at the images above and reflect on the following:
   a. Describe what you see in each image.

   b. Together these images represent a process, what do you think it could be?

   c. Have you ever done any of these kinds of activities? Where and how?

   d. Before plants can go in the ground, where might they start their life?

[1] United States Agency for International Development (USAID). (2012, August 23). *Producing high quality seeds* [Photograph]. Flickr. https://www.flickr.com/photos/usaid_images/8405116827
License: https://creativecommons.org/licenses/by-nc/2.0/legalcode

Problem Solving Activity

Topic 1.1 Task 2:

With a partner read the scenario below and answer the questions that follow:

"Karissa and Alliance are farmers from your neighbourhood hoping to start a nursery and grow horticulture crops such as: cabbages, carrots, eggplant, tomatoes, avocados, pineapple, and passion fruits. However, before they can begin they need your help thinking about the following:"

a. What kinds of horticulture crops are typically grown in your area?

b. Based on your answer above, what kinds should they consider growing?

c. Where could they go to acquire things like seeds, pots, and growing medium for these crops?

d. What tools will they need?

e. Is there anything they might need to prepare before they can plan their horticulture crops to ensure that the plants survive?

1.1 Key Facts

Sourcing planting materials:
Planting materials can be found at:

- Agro-dealers and aggrotech
- Rwanda Agriculture Board (RAB) or National Agricultural Export Development Board (NAEB)
- Cooperatives or farmers in collaboration with RAB

Criteria for selecting good planting materials: When buying seeds always check the information provided on labels such as:

- Expiration date
- Quality of seed
- Purity
- Germination rate
- Absence of pests and diseases
- Vigour, Health, Size

- Good variety
- Certificate
- Cost

Plant growth: Horticulture plants are grown in a variety of ways that ensure the best produce. Some growing methods that are suitable for germinating a tomato plant from seeds do not result in a good producing plant for another type of crop, for example, pineapples. Some crops can be grown multiple ways and still grow viable produce such as passion fruits.

- **Vegetative**: this kind of growth happens when part of a parent plant is taken to grow a new plant.
- **Grafting**: is a method of cutting the top part of a plant that can be fused with the roots of another grafting as a means of growth control, it is used extensively with fruit trees.
- **Generative**: this term refers to the use of seeds in growing new plants.

Growing types by crop:

Generative	Grafting	Vegetative
Eggplant, tomatoes, passion fruits, cabbage, carrots	Avocado trees, passion fruit	Pineapple, carrots

Note: Vegetative propagation of carrots is not usually used as a planting method in Rwanda, however, it is used to attain new characteristics and varieties.

Preparing seeds for planting and germination:

- Seed pelleting: turns a small seed into a larger, round-shaped seed, so seeds can be mechanically sown more accurately in the field.[2]
- Seed priming: Seed priming is a pre-sowing treatment which leads to a physiological state that enables seed to germinate more efficiently
- Soaking in fungicides or insecticides[3]

[2] Seed Dynamics. (n.d.). *Pelleting: Improving a seed's size and weight for precise metering*. https://seeddynamics.com/technology/techniques/pelleting/

[3] Lutts, S., Benincasa, P., Wojtyla, L., Kubala, S. S., Pace, R., Lechowska, K., Quinet, M., & Garnczarska, M. (2016, October 12). *Seed priming: New comprehensive approaches for an old empirical technique*. IntechOpen. https://www.intechopen.com/books/new-challenges-in-seed-biology-basic-and-translational-research-driving-seed-technology/seed-priming-new-comprehensive-approaches-for-an-old-empirical-technique

- Dormancy breaking: Seeds need to be woken up and will only germinate under specific conditions, therefore such seeds must be treated according to the following methods in order to encourage germination and growth:
    - Scarification (a process of roughing or scraping the protective coating of the seed)
    - Leaching (washing with water)
    - Light treatment

Preparing for vegetative propagation:

- Cut the top, leafy part of a pineapple.
- Soak it in clean water for a few days until it begins to root.
- Keep in shade
- Follow up each day to monitor rooting.

Preparing for Grafting:

- Tools and materials: grafting knife, polythene paper
- Select and cut healthy, established rootstock.
- Select and cut the fruit producing scion.
- Cut a notch in both with reciprocal facets and join the rootstock and scion.
- Cover the graft area with polythene.
- Keep in shade and water.
- Follow up each day to monitor the graft.

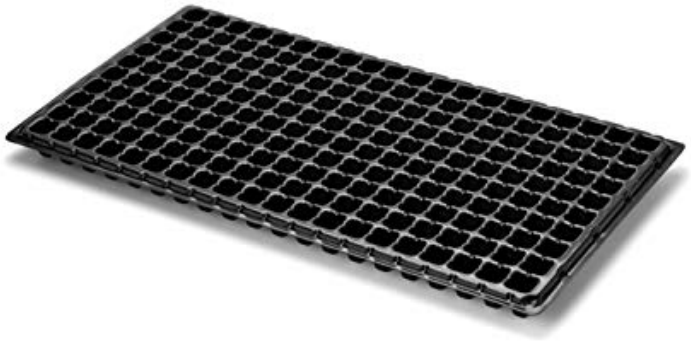
Preparing pots and seed trays: use a bucket or tub to moisten the planting medium. The goal is to get it moist but not sopping wet. Fill the containers and pack the soil firmly to eliminate gaps. Use your finger to make a small hole in the soil for the seed. Check the seed packet to see how deep you should make it.[4]

[5]

Pots

[4] Bazodo Enterprises. (n.d.). *Germination guaranteed: Veg, spinach and fruits*. https://bazodo.com/seeds/90-bazodo-all-variety-seeds-28-types-germination-guaranteed-veg-and-spinach-and-fruits.html

[5] Cutrer, J. (2018, September 10). *Orange clay pots* [Photograph]. Flickr. https://www.flickr.com/photos/joncutrer/49280193866 License: https://creativecommons.org/licenses/by/2.0/legalcode



[6]

Seed trays

Preparing a nursery: Nursery beds should be prepared according to the seasons and crop. Prepare soil mixture in the ratio of 1:1:1 of soil, sand and well-rotted farmyard manure (FYM) or leaf mould and fill the mixture in these seedlings raising structure so that drainage of the excess water on the structure is easy.[7]

- Sunken beds are dug evenly about 15-20 cm below the ground level. This is suitable for dry season or areas that receive less rain.
- Raised beds are prepared at 10-30 cm upwards from ground level and at a width of one meter. A space of 30-40 cm is left between two beds and ultimately it converts into furrows. This is suitable for the rainy season or wetter areas.
- Flat beds are dug so the planted seedlings are level with ground during planting. These are suitable for in between wet and dry seasons.[8]

Types of media: seedlings are grown in a variety of organic and inorganic materials designed to help the seed germinate.

- These media are like a safe environment to help grow to become bigger and stronger.
- Soil: includes rich organ matter and should be sterilised to avoid the risk of soil borne diseases.

[6] Friedman, L. (2017, August 8). *Seedling trays* [Photograph].
Flickr. https://www.flickr.com/photos/lynnfriedman/36244873994/
License: https://creativecommons.org/licenses/by-nc-nd/2.0/legalcode
[7] Tewari, D. (2009, August 29). *Nursery management in vegetables*.
Agropedia. https://agropedia.iitk.ac.in/content/nursery-management-vegetables
[8] The New Zealand Digital Library. (n.d.). *Making the right seedbed for the crop, soil, and climate*. 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&a=d&cl=CL1.16&d=HASH412cd503b5262205ac14c6.6.4

- Soilless media: Using these materials rather than soil allows gardeners to grow healthier plants without the threat of soil-borne diseases.[9]

Planting depth: For seeds, a general rule is to plant at a depth that is two to three times the size of the seed.

Guided Practice Activity:

Topic 1.1 Task 3

In small groups, you will perform the necessary steps to prepare for a variety of horticulture crops to be planted. Your trainer will provide you with the necessary tools and materials. Follow the instructions below to ensure that your seedlings will germinate in the following learning unit:

1. Prepare seeds by treating them with the appropriate method:
   a. Inspect the seeds to ensure quality removing any contaminated or poor seed

   b. Perform scarification, dormancy breaking, pelleting (if equipment is available), water soaking, or a combination of these methods

2. With the help of your trainer, prepare to plant the propagations as well as graft scions to rootstocks.

3. Prepare the soil beds or seedling pots according to the crop and season.
   a. Your trainer will provide your group with a planting medium.

   b. Each person in your group should get a chance to prepare the seedling bed in the seed tray or pot.

4. Once the seedbeds have been prepared, go ahead and plant them in the seedling pots or trays.

5. With the help of your trainer, propagate any produce such as pineapple to ensure it sprouts roots.

6. Perform a plant graft taking the scion from a health producing plant and graft it onto the rootstock.

[9] Dicalite Management Group, Inc. (n.d.). *Perlite and vermiculite in a soilless mix*. Dicalite Management Group. https://www.dicalite.com/2018/05/perlite-and-vermiculite-in-a-soilless-mix/

7. Once everyone has performed these tasks, prepare to discuss your experiences with the group.

Application Activity

Topic 1.1 Task 4:

1. Your trainer will prepare a field visit with a local farmer who is going to acquire seeds and tools for an upcoming planting season. Your group will follow along with the farmer as they buy the materials at an agro dealer or co-op and then assist with some preparation for planting.

2. During this activity, you should make an observation list according to the following requirements.

a. What things do they consider when buying seeds?

b. What kinds of tools can they buy?

c. What kinds of pre-treatment techniques are applied to the seeds before planting?

d. How does the farmer prepare the beds for the nursery?

e. Which techniques do they use while planting/sowing?

Points to Remember

- Planting materials can be acquired through agro dealers, Aggrotech, RAB, NAEB, Cooperatives and farmers in collaboration with RAB.
- Seeds must be treated before they will germinate. Most common forms of seed treatment use light, temperature, and water.
- Plant bedding should be prepared according to crop and temperature

Formative Assessment

Write answers to the following questions.

1. Describe the criteria to use when selecting planting materials.

2. Describe the way a pineapple is prepared for planting versus an avocado tree.

3. Explain the process of seedlings beds and pots preparation.

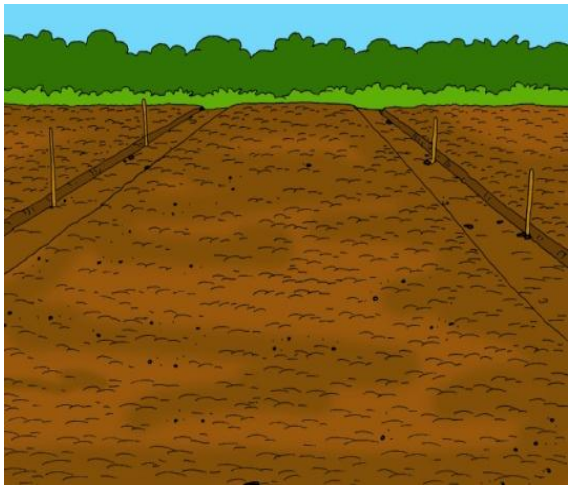
Topic 1.2: Prepare for planting operations

Key competencies

Knowledge	Skills	Attitudes
1. Describe the pre-treatment techniques of planting materials	**1.** Apply pre-treatment techniques of planting material	**1.** Practical
2. Describe handling during transportation of seedlings	**2.** Perform handling during transportation of seedlings	**2.** Careful
3. List planting methods and patterns for horticultural crops	**3.** Identify planting methods and patterns for horticultural crops	**3.** Well documented

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

Topic 1.2 Task 1:



1. Have a look at the illustrations above and reflect on the following:
   a. Describe what the illustrations show.

   b. Have you ever seen or participated in an activity similar to this one?

   c. Where do you think this is taking place?

   d. What do you think the man is holding in the bottom image and what are they doing with it?

Problem Solving Activity

Topic 1.2 Task 2:

In a group, read the scenario below and answer the questions that follow:

"Karissa and Alliance have several different kinds of seedlings in seed trays and pots that have now sprouted. They intend to grow tomatoes and eggplants. Additionally they have heard from a neighbour that carrots have been selling at a very competitive rate and they

would like to enter this market as well. However, this is a new crop and they have never planted it before."

1. Give them advice about how to prepare their land and soil for each crop.

2. Make a list of recommendations they should consider before they can successfully begin the planting operations.

3. Use the questions below to guide your recommendations and advice.
   a. When comparing planting seeds in seed trays to transplanting seedlings in a field what process are similar and which are different?

   b. Which planting patterns or planting arrangement should be used for which horticultural crops?

   c. Will soil treatment techniques apply differently for different seedlings?

   d. How might the handling of seedlings during their transportation to the field be conducted?

1.2 Key Facts

Planting methods:
In general, a farmer who intends to raise a crop has to choose between these two methods of planting: direct seeding and transplanting.

Field planting or Direct seeding - means planting at the crop area with the use of seeds. It is also used to refer to the planting of underground vegetative planting materials directly into the soil. **This method is used for carrots in Rwanda.**[10]

Transplanting - is planting with the use of pre-grown seedlings or plants that have been propagated from seeds. Transplanting has the advantage of reducing the wastage of seeds and offers farmers the chance to transplant only healthy and vigorous seedling for best results. Additionally, correct spacing between each can be easily attained. **This method is used for all other horticulture crops discussed in this module.**

[10] Bareja, B. G. (2019, May 7). *Methods of planting crops: What is direct seeding and what is transplanting?*. CropsReview. https://www.cropsreview.com/methods-of-planting.html#:~:text=In%20general%2C%20a%20farmer%20who,planting%3A%20direct%20seeding%20and%20transplanting

Factors which determine direct seeding or transplanting:

- the crop species to be grown
- ease in planting and survival rate
- farmer's familiarity
- timeliness
- financial capability of the farmer
- return on investment

Methods for field planting:

Broadcasting

- This is a deliberate random scattering of seeds on the field or prepared seed bed. There is no specific or definite inter or intra-row spacing of crops observed.
- Horticulture crops commonly planted by this method are carrots.

Drilling method

- In this method, seeds are placed in shallow furrows created with disc or hoe and then buried.
- The spacing between plants may not be regulated (the spacing between plant to plant in a row is not constant). Many horticulture crops are planted using this method.

Precision planting

- Horticulture crops such as cabbage and tomatoes are planted with a definite inter and intra row spacing (both require 60cm between plants x 90 cm between rows) to achieve a precise plant density.
- This method ensures maximum productivity and high yield of crops.

Maintenance of seedlings in nursery:

Mulching must be done after sowing or planting. Mulching is done by putting a layer of organic material (e.g. wheat straw) around the base of the palm.[11]

Steps of preparing seedling beds:

- Primary tillage (deep tillage, sub soiling and year-round tillage)
- Second tillage
- Soil ready for digging
- Maintain plant spacing (this is discussed in greater detail in the next unit, 1.3).

[11] Klein, P., & Date, A. Z. (n.d.). *Chapter VI: Land preparation, planting operation and fertilisation requirements*. Food and Agriculture Organization of the United Nations. https://www.fao.org/3/Y4360E/y4360e0a.htm

Planting Patterns:

How plants are arranged in the field will depend on the crop, the terrain and soil quality. Poor soil requires closer spacing. Steeper pitched fields require alternate rows to avoid erosion.

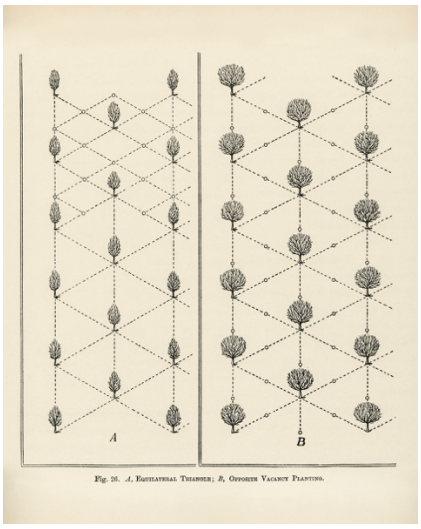
- Square or single row planting is the simplest pattern.

- Double or multiple row planting is a system of growing crops in blocks or strips of two or more rows. This in between row can be used for intercropping a different crop between the two rows of the same crop.

[12]

[12] Bayer Group. (2015, October 6). *Figure 2. A twin row planting with a 38-inch row center* [Photograph]. https://www.dekalbasgrowdeltapine.com/en-us/agronomy/pros-and-cons-of-different-corn-row-spacing.html

- Triangle style of planting is typical for orchards and pineapples. Plants or trees are planted as in rectangular system but the difference being that those in the even numbered rows are midway between those in the odd rows instead of opposite to them.



13

- Alternating rows or strips are preferred when on hilly farmland. A strip is formed by one or more rows of trees planted close together. Rows should be planted along the contours to minimise soil loss. Rows should be planted at the start of the rainy season to ensure germination. Many trees species can be directly sown with good results.[14]

Crops	Planting Arrangement
Cabbage	square, double, alternating
Carrots	double, alternating with onions
Eggplant	square, alternating
Tomatoes	square, alternating
Pineapples	triangle, alternating
Avocadoes	square, triangle, alternating
Passion fruits	square, alternating

[13] Miss May Rivers, & Rawpixel.com. (2017, December 12). *The fruit grower's guide: Vintage illustration of equilateral triangle* [Enhanced photo]. Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Vintage_illustrations_by_Miss_May_Rivers_digitally_enhanced_by_rawpixel_111.jpg
License: https://creativecommons.org/licenses/by-sa/4.0/legalcode

[14] Peace Corps. (1990). *Alternate row planting*. New Zealand Digital Library. https://www.nzdl.org/gsdlmod?e=d-00000-00---off-0envl--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=CL1.6&d=HASHb1669db516271d3af777f8.8.3.3>=1#:~:text=Alternate%20rows%20or%20strips%20(alley,contours%20to%20minimize%20soil%20loss

Methods of fertilization:

- Broadcasting
- Placement
- Starter solutions
- Foliar- applying liquid fertiliser directly to the leaves
- Fertigation- application through irrigation water
- Organic- Manure

Transporting Seedlings:

- Gently water the seedbeds the day before transplanting for easy removal of seedling on the day of transplanting.
- Do not water on the day transplant.
- Prepare the field by marking all the points for planting according to required plant spacing before transplanting vegetable seedlings.
- Carefully uproot the seedlings from the seedbed.
- Plant the seedling immediately when they arrive at the farm.
- Ensure a similar planting depth in the field as in the seedbed.[15]

Guided Practice Activity

Topic 1.2 Task 3:

You will now help Karissa and Alliance plan their land plot.

1. Think back to fields that you have seen in your neighbourhood and how they were prepared for planting.

2. Using your past experience and the information provided in the **1.2 Key Facts** draw a map of how the land should divide and prepared for the four different crops. Make sure to include:
   a. Correct row spacing for each of their crops.

   b. An access for transportation.

   c. A source for water.

   d. Decide how to divide the rows and if they should be elevated, sunken, or flat.

[15] Adjei, L. (2017, September 25). *How to: Transplant vegetable seedlings from nursery to the farm*. MyFarm Blog. https://blog.agrihomegh.com/transplanting-vegetable-seedlings/

e. Mark the points that will be either elevated, sunken or flat.

f. Draw the tools that will be needed.

g. Include notes on how each soil section should be treated.

3. The design of your land plot should logically follow which methods you believe would be best for the crop's future yield.

Scale = 4 Ha

Application Activity

Topic 1.2 Task 4:

1. In small groups, you will prepare for planting operations either in the field or at the training centre's garden. You will need to perform and prepare the following:

a. Prepare soil for transplanting the seedlings.

b. Prepare the soil for direct transplanting and perform direct field sowing of carrot seed.

c. Practice appropriate handling of seedlings before and during their transportation to the field.

d. Explain to your trainer what patterns or planting arrangement are used in the school's garden and how they benefit the horticultural crops being grown there.

e. Compare your drawing with the configuration of the field.

Points to Remember

- Carrots are sown directly into the soil/field.
- All other horticultural crops referred to in this module are generally transplanted in Rwanda.

Formative Assessment

1. Name the three steps for preparing seedling beds.

2. Name the planting methods used for carrots.

3. Name the planting method that is generally used for all other horticulture crops included in this module.

4. Describe how to decide which method of field planting is appropriate for planting horticulture crops.

5. Explain which planting arrangement could be used for an avocado tree orchard.

Topic 1.3: Carrying out planting operations

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe elements to be considered when planting horticulture crop	**1.** Respect the elements that considered in planting material	**1.** Attention to details
2. Describe the way to perform planting techniques	**2.** Apply planting techniques	**2.** Practical
3. List immediate care, waste management procedures, and record keeping	**3.** Apply waste management techniques and record keeping	**3.** Careful

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

Topic 1.3 Task 1:

1. Look at the illustration above and discuss the following questions with a partner:
   a. What do you think is happening here?

b. Have you ever seen this done or participated in this type of activity before?

c. Where might it be happening?

d. What steps might the people need to take after they have finished this activity?

Problem Solving Activity

Topic 1.3 Task 2:

1. In a group read the following scenario and follow the instructions:

Rukundo and Umuhire's seeds have germinated nicely and they have successfully planted their tomato seedlings in the nursery. They decided to maximize space and plant the seedlings 10 cm apart. However, after a few weeks they have noticed that many of their plants show signs of disease."

2. Brainstorm a list of what might have caused their tomato plants to catch a disease.

3. Discuss what other problems might occur shortly after field or nursery planting for the other crops your class is producing.

4. Finally, how would you design a plan for plantings in a nursery or field to best prevent this problem from occurring?

5. Your trainer will assign your group a horticulture crop. You should consult the **1.3 Key Facts** to make a plan for planting your assigned seedling and one other crop that interests your group. In total, you should make two plans and your group will be responsible for planting these crops next lesson.

6. Discuss your answers and present your plan to the trainer and other groups.

7. Take in feedback and ideas from the other groups and revise your plan.

1.3 Keys Facts

The elements to be considered when planting horticulture crops:

- **Planting season:** Each horticulture crop has a specific period of the year during which it should be planted. Some crops have one annual planting cycle whilst other have two.
- **Planting spacing and densities:** When planting any crop, it must be kept in mind that it is important to cover as much area as possible. Do not, however, exceed the prescribed planting density as this will cause lower production due to fungal infection, and also a poor-quality product. Maintaining correct spacing between individual plants is a key to preventing disease.
- **Planting depth for seedlings**: When planting seedlings, a general rule is to plant the plants at the same depth as they were growing in the seed trays, beds or bags. The planting holes must be large enough to accommodate the root ball. However, tomatoes prefer deeper planting. Remove all but the top 3 or 4 sets of leaves, before planting and dig the holes about twice the depth as the seed trays. Tomatoes grow extra roots along the lower portion of their stems and thrive with this treatment.[16]

Crops	Plant/Row spacing	Planted densities	Depth of planting
Cabbage	Plant 60 cm Row: 60 cm	35000- 65000/ha	20 cm
Carrots	Plant: 1.5 cm Row: 30 cm	150 -160/m2	10 to 25 mm or 40 mm
Eggplant	Plant: 60 cm Row: 90 cm	16700/ha.	20-30 mm
Tomatoes	Plant: 60 cm Row: 90 cm	8000-10000/ha	15 cm
Pineapples	Plant: 25 cm x 60 cm x 90 cm Row: 45 cm	31,000/ha	10-15 cm
Avocadoes **Passion fruits**	Plant: 6m Row: 6m Plant: 3m Row: 3m	250-300/ha 4500- 5000/ha	30 cm 6 cm

[16] Republic of South Africa National Department of Agriculture, & AgriSETA. (2006, July). *Learner guide: Primary agriculture: Plant crops under supervision*.
AgriSETA. https://www.agriseta.co.za/downloads/LearningMaterial/116200_LG.pdf

Crops	Planting dates
Cabbage	Beginning of Feb and Nov.
Carrots	Beginning of Feb and Nov.
Eggplant	Mid Feb - Mar.
Tomatoes	Begging of Nov. and April
Pineapples	Feb-Mar
Avocadoes	Mid-April
Passion fruits	Mid-Mar.

Guided Practice Activity

Topic 1.3 Task 3:

With your group, you will now perform the transplanting of your seedlings into the training centre's nursery or field that you have prepared during the previous learning unit. Follow the instructions below:

1. Go back to the seedlings you have planted in either pots or seed trays and recorded which seeds, if any, did not germinate.

2. Following your group's plan, proceed in planting your assigned and chosen crops paying special attention to maintaining correct planting depth and spacing and between each plant.

3. Once all of the seedlings have been planted, count every plant in the nursery area or field and record this count to check if the correct planting density has been attained.

4. Then perform the necessary immediate care steps outlined in the **1.4 Key Facts**; weeding, mulching, watering, fertilizing, managing waste and recording data.

5. At the end of this activity have your group reflect over the results of your germinated seedlings and the planting process. Record any challenges you faced and what ways you could improve both steps for next time. Share your findings with your class.

1.4 Key Facts

Post-planting immediate care:

Weeding: Three or four times depending on growing cycle and the presence of the weeds in the field for all crops.

- Physical and cultural methods (i.e. pulling up weeds manually)
- Chemical methods (pesticides)

Mulching:

- Must be done after sowing or planting horticulture crops.
- Types of mulch: organic mulch, inorganic mulch, compost, straw or hay.

Watering: Watering twice a day, morning and evening is best when possible. Methods for watering horticulture crops include:

- Furrows
- Hand irrigation
- Sprinkler
- Drip irrigation

Fertiliser application: Apply fertiliser at planting time and after weeding. Additional application should occur for fruits when the plant shows the symptom of nutrient deficiency. Methods include:

- Broadcasting
- Placement
- Starter solutions
- Application through irrigation water (Fertigation)

Waste management during planting operations:

- **Recycling**: Unused plant parts of the planting material can be composted to make compost.
- **Re-use**: Bags and other materials that were used during planting operations but were not in contact with harmful chemicals can be collected and be re-used in other operations.
- **Safe disposal**: Containers of seeds and other products used during planting operations and were in contact with harmful chemicals can be disposed in prepared area where they are likely to cause the least harm to environment following guidelines.

Completion of records: data should be record in a table during planting for the following information;

- Site location
- Variety/Cultivar
- Date of planting
- Spacing used (planting densities)
- Planted area
- Fertilisers used

Example:

Date of planting	Variety	Site	Area used	Fertiliser used/qt
Nov. 3rd	Tomatoes	Muhanga farm, parcel 3	.75 ha	NPK (17-10-27) 187.5 kg

Activity 3: Application

Topic 1.3 Task 4:

Your trainer will now organize a field visit to a nearby horticulture nursery. In order to validate your knowledge, your group should make an observation list following the questions and prompts below:

1. Measure out the spacing and calculate the spacing density.

2. What post planting immediate care practices that are performed?

3. How is waste manage after planting?

4. Did the farmer have any problems with germination/sprouting? If so, what are possible reasons?

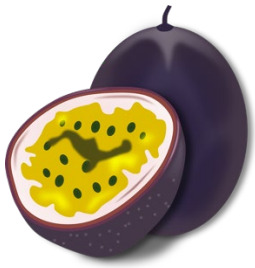
Points to Remember

- It is important to select crops based on the local conditions of the area and season. Failure to do so will result in little to no produce.
- Maintaining correct spacing between individual plants is a key to preventing disease.
- Following the planting of seedlings, there are several steps needed in order for the plants to thrive - weeding; mulching; watering; and fertilizing. In addition, one needs to manage waste and record data to keep track of plant conditions and growth.

Formative Assessment

1. Fill in the table below with the appropriate plant name and planting dates.

Crop	Name and Planting Date
a. 	**Example:** Cabbage Beginning of February and November
b. 	
c. 	

d. 	
e. 	
f. 	
g. 	

2. Name at least two factors to consider when planting:

-
-

3. Name at least three things one has to do after planting seedlings to help the plants grow:

-
-
-

Self-Reflection

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

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

My experience **Knowledge, skills and attitudes**	**I don't have any experience doing this.**	**I know a little about this.**	**I have some experience doing this.**	**I have a lot of experience with this.**	**I am confident in my ability to do this.**
Describe criteria for selecting horticultural planting materials					
Describe methods of horticultural planting materials pre-treatment					
List tool and soils that need to be acquired to prepare for planting					
Select good horticultural planting materials					
Perform horticultural planting materials pre-treatment					
Acquire tools and soils required to prepare for planting					
Describe the pre-treatment techniques of planting materials.					
Describe handling during transportation of seedlings					

List planting methods and patterns for horticultural crops.					
Apply pre-treatment techniques of planting material					
Perform handling during transportation of seedlings					
Identify planting methods and patterns for horticultural crops.					
Describe elements to be considered when planting horticulture crop					
Describe the way to perform planting techniques					
List immediate care, waste management procedures, and record keeping					
Respect the elements that considered in planting material					
Apply planting techniques					
Apply waste management techniques record keeping					
Describe criteria for selecting horticultural planting materials					

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

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

Unit 2: Assistance in horticultural crops maintenance

Topics

2.1 Perform horticultural crop maintenance practices

2.2 Assist in managing pests and diseases

2.3 Use of fertilisers on horticultural crops

2.4 Pruning horticultural crops

Unit Summary:

This unit will provide you with the knowledge, skills, and attitudes required to perform horticultural crops maintenance practices; assist in managing pests and diseases; use fertilisers on horticultural crops and prune horticultural crops.

Self-Assessment: Unit 2

1. Observe the unit illustration above. What do you see? What do you think this unit will be about?

2. Fill in the self-assessment below.

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

My experience **Knowledge, skills and attitudes**	**I don't have any experience doing this.**	**I know a little about this.**	**I have some experience doing this.**	**I have a lot of experience with this.**	**I am confident in my ability to do this.**
List the tools, materials and equipment used in horticulture maintenance.					
Perform irrigation techniques in horticultural crops production.					
Perform weeding and hoeing in the field of horticulture crops.					
Describe symptoms and damages caused by pests and disease.					
Explain pesticide application process.					
Identify pests and symptoms of disease and damages in horticultural crops.					

Match correct pesticide for managing pests.					
Describe types of fertilisers.					
Choose fertilisers following set criteria.					
Make compost.					
Apply fertilisers using recommended techniques.					
Describe the purpose of pruning.					
Identify tools and equipment for pruning.					
Identify pruning objectives.					
Select tools and equipment.					
Perform pruning techniques.					

Topic 2.1: Perform horticultural crop maintenance practices

Key Competencies:

Knowledge	Skills	Attitudes
1. List out tools, materials and equipment used in maintenance	**1.** Select tools, materials and equipment in horticulture crop maintenance	**1.** Attention
2. Describe irrigation techniques	**2.** Perform irrigation techniques in horticultural crop production	**2.** Practical.
3. Explain weeding and hoeing procedures	**3.** Perform weeding and hoeing in a field of horticulture crops	**3.** Detail oriented

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

Topic 2.1 Task 1:

Have a look at the images above and reflect upon the following:

1. What do you think is happening in each image?
2. Do you recognize the horticulture plants being grown in each image? If so, list them.
3. Have you ever seen examples of what is shown in the images?
4. Where and when?
5. Think back to your experience with maintaining food crops. Do you see any similarities?

Problem Solving Activity

Topic 2.1 Task 2:

With a partner read the scenario below and answer the questions that follow:

Murisa and Semana are new farmers who have successfully planted cabbage, tomatoes, and eggplant in their nursery and now the plants are becoming well established. They have followed the appropriate procedures of plant spacing and density, and were attentive to all the correct procedures immediately after they had planted their crops. After a few weeks, they see that the tomatoes have started to flower while some of the eggplants are not growing as tall as they had hoped. Additionally their cabbages have been disappearing gradually every night."

1. Think back to your experience with food crop production and how those crops were maintained.

2. What do you think might be causing some these problems?

3. Make a list of actions they should take to overcome these problems and the tools that are needed.

4. Finally, discuss how maintenance of horticulture crops might differ from food and cash crops.

2.1 Key Facts

Maintenance of horticulture crops includes many of the same procedures performed during the post-planting immediate care. They include:

- Weeding
- Fertilizing
- Watering
- Thinning

Additional maintenance after crops have become well established includes;

Earthing up: A technique of drawing soil up around stems to encourage blanching. Earthing up is important maintenance practice for horticulture crops because it provides support to the base of the plant and also gives chances for the formation of a better root

system. Earthing up should be done before rainy season for avoiding waterlogged conditions.

Thinning: The removal of flowers or young fruit to permit the remaining fruits to grow more rapidly and to prevent development of such a large crop that the plant is unable to flower and set a commercial crop the following year.[17] Methods include:

- By hand
- Mechanically
- Chemically

Supporting: Supporting refers to the provision of a small structure, either a stake or lattice beside a plant in order to provide it with support while it grows.

- Tomatoes and eggplants require support after they are established
- Passion fruit vines need a more elaborate lattice structure to climb

Fencing: Fences are used to protect valuable horticulture crops from excessive wind, hungry animals and discourage potential thieves.

- If the nursery is situated in a windy area, the fence must be higher and stronger toward the prevailing wind
- Large plants can serve as fences however their need for resources; water, sun and nutrients make them unsuitable for nursery application
- Suitable materials include: Timber, Wire, Stone or brick

Irrigation systems: An adequate long-term water supply is important for plant growth during the entire growing cycle. When rainfall is not sufficient, the plants must receive additional water from irrigation. Methods include:

- **Hand irrigation**: A simple irrigation method to bring water from the source of supply, e.g. a well, to each plant with a bucket or a watering can. This can be a very time-consuming method and involves very heavy work. However, it can be used successfully to irrigate very small plots of land that are close to the water source.
- **Furrow irrigation:** Furrows are small channels, which carry water down the land slope between the crop rows. Water infiltrates into the soil as it moves along the slope. The crop is usually grown on the ridges between the furrows. This method is suitable for all row crops and for crops that cannot stand in water for long periods (12-24 hours). However, it is a labour intense method due to digging and maintaining such ditches and channels.[18]
- **Sprinkler Irrigation:** Sprinkler irrigation is a method of applying irrigation water that is similar to natural rainfall. Water is distributed through a system of pipes

[17] Encyclopedia Britannica. (n.d.). *Fruit farming: Soil management, irrigation, and fertilization*. https://www.britannica.com/topic/fruit-farming/Soil-management-irrigation-and-fertilization
[18] Energypedia. (2020, July 14). *Surface irrigation*. https://energypedia.info/wiki/Surface_Irrigation

usually by pumping. It is then sprayed into the air through sprinklers so that it breaks up into small water drops that fall to the ground. Sprinkler irrigation is suited for most row, field and tree crops; and water can be sprayed over or under the crop canopy. Sprinkler irrigation is adaptable to any farmable slope, whether uniform or undulating.[19]

- **Drip irrigation:** With drip irrigation, water is conveyed under pressure through a pipe system to the fields, where it drips slowly onto the soil through emitters or drippers that are located close to the plants.[20]

Tools:

Weeding/Earthing up	Irrigation	Thinning	Supporting
● Wheelbarrow ● Hoes ● Spades ● Panga	● Hose ● Water barrel ● Bucket ● Watering can	● Hand shovels ● Pruning shears ● Knapsack sprayer	● Stakes ● Sticks ● String ● Fencing

Guided Practice Activity

Topic 2.1 Task 3:

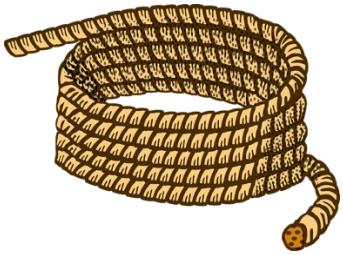
Follow the instructions below:

1. Match the tools pictured in boxes A-K to the proper maintenance activity listed below. There are some tools that will be used in multiple activities.

2. Be prepared to explain your answers.

[19] Brouwer, C., Prins, K., Kay, M., & Heibloem, M. (n.d.). *Irrigation water management: Irrigation methods: Chapter 5 Sprinkler irrigation*. Food and Agriculture Organization of the United Nations. https://www.fao.org/3/s8684e/s8684e06.htm

[20] Stauffer, B. (n.d.). *Fact sheet: Drip irrigation*. Seecon International. https://sswm.info/sswm-solutions-bop-markets/affordable-wash-services-and-products/affordable-technologies-and/drip-irrigation

a. 	b. 
c. 	d. 
e. 	f. 
g. 	h. 

i.	j.
	 [21]
k.	**l.**
	 [22]

Weeding hoeing: _____

Earthing up: _____

Thinning: _____

Irrigation: _____

Mulching: _____

Supporting: _____

Application Activity

Topic 2.1 Task 4:

1. Within your group, your task is to gain practical experience operating and maintaining different types of irrigation systems.

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[21] Pxfuel. (n.d.). *Cucumber, bud, potted plant, support, nature, leaf, plant part, growth, green color, close-up* [Photograph]. https://www.pxfuel.com/en/free-photo-jxcvf
Free for commercial use, DMCA

[22] All photos (except j) are from Pixabay.com; License: https://pixabay.com/service/license/

2. If your training centre does not provide access to other types of irrigation systems which are suitable for horticulture crop maintenance, then your trainer will arrange for an off campus field visit.

3. During your practical experience observe the following:
   a. Which irrigation methods are applied?

   b. Which crops are being irrigated?

   c. What are the materials available?

   d. How are these systems maintained?

4. After you have gained practical experience with the irrigation systems, proceed to performing the other maintenance related tasks listed below:
   a. weeding/hoeing
   b. earthing up
   c. thinning
   d. mulching
   e. supporting
   f. check your facility for fencing structures and record relevant details

5. Share your experiences with your fellow trainees and trainer.

Points to Remember

- Furrows irrigation is suitable for all row crops and for crops that cannot stand in water for long periods.

- Thinning permits the remaining fruits to grow more rapidly and leaves space for other plants.

- Eggplants, tomatoes, and passion fruits require support after they have become well established plants.

Formative Assessment

1. Describe two irrigation systems that are commonly used in your area and discuss the advantages and disadvantages of both.

-
-

2. Describe what thinning is and why it is done.

3. Answer with **true** or **false**:

a. Many of the maintenance practices of horticulture crops include the same procedures performed during the post-planting immediate care.

b. A technique of drawing soil up around stems to encourage blanching is called 'Earthing up'

Topic 2.2: Assistance in managing pests and diseases

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe symptoms of damages caused by pests and diseases	**1.** Identify symptoms of damages caused by pests and disease	**1.** Observant
2. List pests and diseases which damage horticultural crops	**2.** Identify pests and diseases of horticultural crops based on symptoms	**2.** Attentive
3. Explain pesticide application process	**3.** Match correct pesticide for managing pests or diseases	**3.** Careful

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

Topic 2.2 Task 1:

Have a look at the image above and reflect upon the following:

1. What do you think is happening in image?

2. Which horticulture plant is displayed?

3. How might the image be related to the previous unit?

4. Think back to your experience controlling pests in the food crops production and generate a short memory list of things that you learned then and think what will help you in this learning unit.

Problem Solving Activity

Topic 2.2 Task 2:

1. Read the following scenario together as a class and follow the instructions individually.

   Rukundo and Uwimana are farmers that are new to your area and growing horticulture crops. They are not familiar with the local issues surrounding pest control and need your help. They have hired you to do some investigating in your local community to find out what kind of pest damage and potential diseases are common to horticulture crops in your area.

2. Your task is to collect damaged 2-3 samples of different horticulture crops that have been damaged.

3. Going around to local horticulture farmers ask permission to obtain damaged leaves, fruits, stems or roots of a horticulture plant, and bring them to class.

4. If you cannot obtain the parts of the plant take a photograph using a smart phone, or simply take notes to describe the plant appearance.

5. Present your samples to the class and with the help of your trainer and fellow trainees try to identify what the cause of the damage is.

6. Use the **2.2. Key Facts** and the following questions to guide your reasoning:
   a. What are the symptoms or signs of damage?

b. Was the damage caused by a disease or a pest?

c. What could happen if the crop goes untreated?

7. Together your class will make a list of all the diseases and pests found in your neighbourhood.

2.2 Key Facts

Cabbages:

- **Diseases:** Black Rot, Leaf Spot and Blight (Alternaria leaf blight)
- **Symptoms:** Discoloration of tissues and dwarfing of plant
- **Pests:** Aphids, Cutworms, Leaf miners
- **Damages:** Root damage, plants wilt and die, yield reduction

Carrots:

- **Diseases:** Alternaria leaf blight, Black Rot, Bacterial leaf blight
- **Symptoms:** Green-brown colour, leaves turn black
- **Pests**: Root knot nematodes, Cutworms, The African Army Worm
- **Damages**: Galls or swellings on the fleshy taproot

Tomatoes:

- **Diseases:** Anthracnose, Black Mould, Fusarium wilt
- **Symptoms:** Dwarfing of plant**,** brown to black mildew, yellowing and wilting of leaves
- **Pests:** Cutworms, Aphids, Thrips, Spider Mite, Root-knot Nematodes
- **Damages:** Yellowing of the crops, wilting and rotting, soft rots, discoloration of plant

Avocado

- **Diseases:** Algal Leaf Spot, Anthracnose
- **Symptoms**: Orange-red spots on both upper and lower surfaces of leaves
- **Pests**: Fruit Flies, Scales, Thrips, Spider Mites
- **Damages:** Soft rots, reduced yield

Eggplant

- **Diseases:** Blossom-end Rot, Damping-off
- **Symptoms:** Small water-soaked area on end of fruit where the blossom was occurring on unripe fruit
- **Pests:** Cutworms, Budworm, Whiteflies, Root-knot, Nematodes

- **Damages:** The infested roots eventually rot, and affected plants die yield reduction

Pineapples

- **Diseases:** Bacterial Heart Rot, Black Rot, Mealy Bug Wilt Rot, Phytophthora Heat Rot
- **Symptoms**: Discoloration of tissues, presence of mealy bug
- **Pests:** Nematodes, Pineapple Red Mite, White Rubs
- **Damages:** Juice can enter leaves through wounds, fruit rot, reduced the crop yield

Passion fruits

- **Diseases:** Fusarium Wilt, Collar Rots
- **Symptoms:** The die back of the centre, wilting
- **Pests:** Mealy bugs, Aphids, Leaf Mining Flies, Fruit Flies, Spider Mites
- **Damages:** Causes plants to wilt and die, fruits rot and discoloration of the plant parts[23]

Guided Practice Activity

Topic 2.2 Task 3:

1. The task of this activity is to learn how to determine which pest control methods can be used to eliminate common pests of horticulture crops.

2. First review safe handling practices of using pesticides in **2.3 Key Facts**.

3. Your trainer will provide various packages of many different pesticides for treating different pests of horticulture crops.

4. Using the list from the previous activity, your trainer will divide these examples among your groups.

5. Your groups should read each label carefully and decide which pesticide could be appropriate for the damaged crop you are responsible for.

6. Compile your results in a list to share with the rest of the class when you have finished reading the labels.

[23] SNV Netherlands Development Organisation. (n.d.). *Smallholder horticultural production and business: Trainer's manual*. https://snv.org/cms/sites/default/files/explore/download/rarp_2016-horticulture-trainers-manual.pdf

7. Discuss among your group how these pesticides should be applied.

8. Referring back to your experience with Food Crop Production make a list of feasible alternative methods for controlling these pests.

2.3 Key Facts

The factors which govern how to use a pesticide are:

- Control measures required to reduce any potential risk to the environment or surrounding wildlife.
- The type of pest you wish to deal with.
- The environment that the pest thrives in.
- The optimal method of delivery.
- The equipment available for delivering the pesticide.

Guidelines for safe application of pesticides:

- Always use personal protective equipment (PPE) when mixing and spraying pesticides.
- PPE includes long sleeved shirt; long trousers; goggles, glasses or a face shield to protect the eyes; boots (preferably rubber or impermeable boots); gloves (preferably rubber or impermeable gloves); dust mask (for dry formulations) or respiratory protector; hat.
- Use clean pumps and clean water for mixing the pesticides.
- Use strictly pesticide application equipment and not basins/buckets for mixing & application of pesticides.
- As a guiding principal, always use pesticides as minimally as possible. Never use more than the recommended application.
- Exercise extreme caution in every step of the procedure from initial calculations, to mixing, application and clean up.

The success of pest control operations by pesticide application greatly depends on the following factors:

- Quality of pesticide
- Timing of application
- Quality of application and coverage
- Proper dosage should be applied evenly
- The toxicant should reach the target
- Proper density of droplet on the target[24]

[24] Plant Health Engineering Division, NIPHM. (n.d.). *Introduction*. https://niphm.gov.in/Recruitments/PHE-ASO-Manual-22042013.pdf

Pesticide application methods:

- **Directed spraying**: This method is used to spray insecticides directly on insects to avoid overuse of pesticides or contamination.
- **Foliar**: Spraying of pesticides on leaves.
- **Basal application**: A low-pressure spray directed to the lower portions of a tree trunk (from the ground up to 50 cm). This type of application is used with insecticides to control borer pests in some fruit trees.
- **Broadcast**: Applying pesticide uniformly to an entire area or field.
- **Soil injection**: Places the pesticide below mulch or turf and directly into the root zone of the tree.[25]

The reasons for combining pesticides are:

- To increase the effectiveness of one of the chemicals
- To provide better control than that obtained from one pesticide
- Control different types of pests with a single application
- Dusting
- Spraying
- Granular application

Equipment for use of pesticides:

- Sprayers
- Chemicals
- PPE

Application Activity

Topic 2.2 Task 4:

You will now perform the application of pesticides to the horticulture crops being grown in your school garden. Use the checklist to guide your practical activity:

✔ Practice safe procedures when handling the pesticides.

✔ Select the tools required for mixing and applying the pesticides.

✔ Correctly measure and mix pesticides.

[25] Popenoe, J. (2018, November). *Pesticide application methods*. Citrus Research and Education Center (CREC) - University of Florida, Institute of Food and Agricultural Sciences. https://crec.ifas.ufl.edu/media/crecifasufledu/extension/extension-publications/2018/2018_november_pesticide.pdf

✔ Apply pesticides to various crops using different methods appropriate for each crop.

Points to Remember

- Always wear a PPE when handling pesticides.
- Look for symptoms of damage to the plant to identify which pest is the cause.
- Always take steps to reduce any potential risk to the environment when using pesticide.

Formative Assessment

1. List the pests which effect two different horticulture crops and what signs you can use to identify them.

2. Demonstrate correct application of pesticide on tomatoes and cabbage.

Topic 2.3: Use fertilisers on horticultural crops

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe types of fertilisers	**1.** Choose fertilisers following criteria	**1.** Confident
2. Explain process to make compost	**2.** Make compost	**2.** Practical
3. Describe fertilisers application	**3.** Apply fertilisers using recommended techniques	**3.** Work-oriented

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

Topic 2.3 Task 1:

1. Think back to the module about food crop production and the Learning Unit that dealt with using fertilisers. What do you recall?

2. What do you think is happening in the illustration?

3. Do you have any experience in such a situation?

4. What might the young man be thinking?

Problem Solving Activity

Topic 2.3 Task 2:

1. With a partner read the three scenarios of different farmers who need help identifying the right fertiliser for their crops.
   a. Olivier is a horticulture farmer who also keeps five cows. He has no budget for fertilisers.

   b. Haruna is a horticulture farmer with a nursery and has no budget to spend on fertilisers. However, his neighbour has recently harvested a crop of beans and tomatoes. The waste and dumped produce from this harvest is sitting in a large pile that needs to be removed soon.

   c. Pascal works for a well-funded cooperative that needs to increase their yield for tomatoes.

2. Record your recommendations and prepare to share with the rest of the class.

2.4 Key Facts

Always consider the following before applying fertiliser:

- Amount of fertilisers
- Methods of application
- Time of application

Method of application:

- Broadcasting
- Row or band placement

- Top dressing and side dressing
- Foliar (leaf) application
- Direct application in the soil
- Fertigation (fertiliser incorporated into the irrigation water)

Organic fertilisers:

- Compost
- Green manure
- Farmyard manure
- Agriculture inputs shops

Making compost: The main consideration is if the compost is best suited to soil incorporation prior to crop establishment, or as surface-applied mulch after the crop has been established. Good quality compost is most readily achieved materials such as crop waste, straw and leafy materials.[26] Steps to compost:

1. Choose your type of backyard compost bin
2. Choose your compost location
3. Alternate layers
4. Kitchen and yard waste can be added as they accumulate
5. Maintain your compost bin

Inorganic or commercial fertilisers:

Simple fertilisers: Contain one only of the following macronutrients.

- N = Nitrogen Components (Ammonia, Urea, and Ammonium Nitrate)
- P = Phosphorus Components
- K = Potassium Components

Nutrients in industrial fertilisers:

Nitrogen (N)

- Promotes leafy plant growth, faster plant growth.
- Use on lawns and other plants with lots of green leaves
- **Application:** Nitrogenous fertilisers must be applied in split doses so that the N loss through leaching and washing could be reduced as N being readily soluble and highly mobile, is subjected to these losses very easily. It is essential that half of the total quantity of the required N should be applied as basal and rest half in 2-3 split doses. Sandy soils need split application of N for a reduced loss of N through leaching.

[26] Paulin, B., & O'Malley, P. (2008, July). *Compost production and use in horticulture*. Department of Agriculture and Food, Western Australia. https://researchlibrary.agric.wa.gov.au/cgi/viewcontent.cgi?article=1197&context=bulletins

Phosphorus (P)

- Promotes strong roots, healthy fruit, blooming
- Use on flowers and flower beds
- **Application:** Except in acidic and highly alkaline soils, the P must be applied in one dose as basal placement but in acidic soils rock phosphate, bone meal or basic slag may be applied at least a fortnight before sowing or crop planting whereas in alkaline soils spraying of phosphate has given better results.

Potassium (K)

- Promotes disease resistance, growth of fruit
- Use on fruit bearing plant
- **Application:** The potassium fertilisers should be applied in a single dose as basal placed but split application along with N as top-dressing has given better response in heavy soil types.

Calculation of mixed fertiliser ratios: The relative proportion of plant nutrients in mixed fertilisers is shown numerically. For example, in a fertiliser with the numbers NPK 2-3-2 indicates that it contains:

- 2 parts Nitrogen
- 3 parts Phosphates
- 2 parts Potassium

Example 1: 17-17-17 = 1:1:1

Example 2: 17-34-17 = 1:2:1

Guided Practice Activity

Topic 2.3 Task 3

1. Your trainer will divide you into groups and assign your group a crop.

2. In your group chose one crop that interests the group.

3. Use the information in **2.4 Key Facts** and the table in the **2.5 Key Facts** to calculate the amount of fertiliser needed for your group's two different crops using the area of your school's garden as the area for calculation.

4. Calculate the amount for organic fertiliser and inorganic fertiliser needed for both crops.

5. Fill in the table with your calculations.

	Organic Fertiliser	Inorganic Fertiliser
Crop 1:		
Crop 2:		

2.5 Key Facts

Plants	Inorganic Fertilisers	Initial application	Post weeding/Earthing up	Organic Fertilisers
Cabbages	LAN NPK (15-15-15)	200Kg/ha 250 Kg/ha	At six weeks after planting, apply 350 kg/ha of LAN	30- 40t/ha
Carrots	NPK 17-17-17 Kg/Ha	300Kg/ha	At 7 weeks after planting applying 3,5g per plant	20-30t/ha
Tomatoes	NPK (17-10-27)	250kg/ha	450kg/ha	20-30t/ha
Avocadoes	Urea MOP TSP	1800kg/ha 120 kg/ha 80 kg/ha	Nitrogen (100-200 Kg N/ha) is best applied in 8 - 10 applications by fertigation, urea, totalling 110 kg/ha.	35-40t/ha
Eggplant	NPK (10-20-20)	350kg/ha	100KgN/ha 3 weeks after transplanting and 200kgN/ha at fruiting	25-30t/ha
Pineapples	NPK 17-17-17 Kg/Ha	300kg/h**a**	300kg/ha every two months during early growing season	10-15t/ha
Passion fruits	NPK (10-20-5)	300kg/ha Basal fertilisers rich in potassium like NPK 17.17.17	Top dressing using CAN and NPK 23.23.0 applying 3,5g per plant	20-30t/ha

Application Activity

Topic 2.3 Task 4:

1. The task of this activity is to gain practical experience producing compost. Either in your school nursery or in cooperation with a local farmer perform the following steps.
   a. With your classmates, brainstorm sources of organic waste.

   b. Locate a space best suited for compost.

   c. Prepare the space.

   d. Collect the waste.

   e. Start composting process.

2. With your classmates and trainer create a plan for how best to maintain the compost in a sustainable way, e.g. who will monitor the compost in the future, what happens if one source of waste is exhausted?

3. As a group, brainstorm ways of how to make your compost project profitable, e.g. are there other farmers in the area who need to dispose of their waste, and they are willing to pay for it? Or, are there local farmers who are in need of high-quality organic fertiliser?

Points to Remember

- Good quality compost is most readily achieved through materials such as crop waste, straw and leafy materials.
- The relative proportion of plant nutrients in mixed fertilisers is shown numerically.
- N = Nitrogen; P = Phosphates; K = Potassium

Formative Assessment

Answer with true or false:

1. NPK is a mixed fertiliser.

2. Compost is an organic fertiliser.

Write answers to the following:

3. Name three relevant criteria for helping choose the correct fertiliser.

-
-
-

4. Describe how the three micronutrients help plants grow.

a. Nitrogen:

b. Phosphorus:

c. Potassium:

Topic 2.4: Prune horticultural crops

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe the purpose of pruning	**1.** Identify pruning objectives	**1.** Observant
2. Identify tools and equipment for pruning	**2.** Select tools and equipment	**2.** Attentive
3. Describe pruning process	**3.** Perform pruning technique	**3.** Work-oriented

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

Topic 2.4 Task 1:

1. Look at the illustration and reflect upon the following:
   a. Describe what the illustration might represent.

   b. Why might this process be necessary for yielding good horticulture produce?

Problem Solving Activity

Topic 2.4 Task 2:

1. Read the following scenario with a partner and follow the instructions bellow:

   Mukamana and Uwimana are farmers produce eggplant, passion fruits, tomatoes, avocadoes in farms within five different fields. All of their crops have gown to be well establish plants free of diseases and pests. They have followed the correct fertiliser procedures up until this point. It is now approaching the harvest season but there plants have produced very little fruits. Particularly leafy tomato plants have only small green fruits while the avocado trees have produced many hard to reach fruits at the top of their branches.

2. With a partner, brainstorm ideas of what could be the cause of their unproductive plants.

3. Also, create a list of possible recommendations and solutions to overcome these problems for each crop, i.e. eggplant, passion fruit, tomatoes, avocadoes.

4. Make a list of tools that can contribute to the solutions you have provided.

5. Prepare to share your ideas with you trainer and fellow trainees.

2.6 Key Facts

Purpose and objectives for pruning: Pruning is an important step in the cultural management of horticulture orchards, farms and nurseries. The objects and purpose of pruning can be summarized as the following:

- Maintains health plant and correct size
- Minimises fertiliser application
- Promotes uniform flowering

- Promotes uniform ripening
- Increases yield
- Prevents diseases
- Facilitates effective harvesting

Types of pruning:

- **De-suckering**: Refers to cutting off the smaller stemming growth at the leaf or branch axel
- **Plant training**: The practice of controlling the shape, size and direction of plant growth through pruning or tying the plant to a fixed location
- **Removal** of dead or unwanted leaves and branches

Pruning tools:

For bushes

- Shears
- Hand Shears (Hand Pruners)
- Lopping Shears (Loppers)
- Hedge Shears

For trees

- Saws
- Manual Saws
- Power saws
- Pole saws
- Pole pruners
- Pruning knife and rasp
- Ladders

Disinfection/sterilisation of cutting tools: Always clean your tools before and after pruning to avoid contamination with the living plants. Soak and wash the tools using:

- Chlorine Bleach
- Ethanol or Isopropyl Alcohol
- Trisodium Phosphates (TSPs)

Training

- Open centre
- Vertical training
- Central leader
- Horizontal leader

Guided Practice Activity

Topic 2.4 Task 3:

Your task is to observe and record the shape and structure of pruned and unpruned horticulture crops.

1. Using the school's garden or a local horticulture nursery carefully observe the shape and structure of eggplant bushes, passion fruit vines, tomato plants, and the avocadoes trees.

2. Pay attention to how the shape of these plants does or does not provide the following:
   - sunlight for energy
   - access to water
   - keeps it strong in case of wind or other disturbances
   - allows most of the plant's energy to produce fruit i.e. no excessive leaves/suckers
   - how easy these fruits will be to harvest from the plant

3. Look for both examples that you think have been pruned well and examples of poorly or unpruned plants.

4. Using the space below, draw a before and after illustration of two different kinds of plants you could see yourself growing one day. In the left column draw an example of a tree or plant that needs to be pruned. In the right column, draw the same kind of plant with a correctly pruned shape.

BEFORE (needs pruning)	AFTER (good pruning)

5. After you have made your drawing briefly explain how the before illustration represents a plant that needs pruning i.e. what can we see that gives us evidence that it should be pruned.

6. Explain how pruning should be done for both of your plants by consulting the **2.7 Key Facts.**

2.7 Key Facts

Tomatoes

- Training methods: cages, string trellis, central ladder, cloth ties.
- Start training when the plant is 4 to 6 cm tall and starts flowering until harvesting.
- Prune all suckers and their leaves below the first flower cluster.

Avocadoes

- Training methods: tree training, open centre, centre leader.
- Training should begin immediately following planting and pruning should be done on a case by case basis, as trees are highly individual.
- Prune horizontal branches for trees grown on slopes, rejuvenation required, and remove dead wood.[27]

Eggplant

- Training methods: Using wire cages, string trellis, central leader, cloth ties.
- Start training when the plant starts flowering until harvesting.

[27] *Avocado tree pruning basics*. (2013, April 22). California Avocado Commission. https://www.californiaavocadogrowers.com/cultural-management-library/avocado-tree-pruning-basics

- Prune by removing old leaves from the lower portions of the plant. Prune to the lowest growth.

Passion fruits

- Training methods: open centre, central leader, and horizontal leader trees.
- Supporting in passion fruit must done after planting.
- Cut off any dead vines. Prune away up to one-third of the existing vines annually to promote new growth.[28]

Application Activity

Topic 2.4 Task 4:

Either in your school garden or at a local field visit to a nursery you will now practice pruning horticulture crops. In a group, you should carefully follow the instructions bellow:

1. Each group will be assigned a crop, once you know which crop you are responsible for, select all the necessary tools for the job.

2. Each group member should get a chance to prune a plant.

3. When each member is finished, have your trainer come and inspect the work.

4. Once your inspector has approved the work of all members of the group, your group should return and sterilise the tools.

5. Once all of the tools have been sterilised each group will switch crops and repeat the pruning process.

Points to Remember

- Diligent pruning is extremely important for growing eggplant, passion fruits, tomatoes, avocadoes.

- Always sterilise pruning tools after using them.

- Plant training is the practice of controlling the shape, size and direction of plant growth through pruning or tying the plant to a fixed location.

[28] Hessong, A. (n.d.). *How to prune passion fruit*. SF Gate. https://homeguides.sfgate.com/prune-passion-fruit-37928.html

Formative Assessment

1. List three objectives of pruning and describe how they are achieved.

-
-
-

2. What are the four horticulture crops that require pruning? List two tools that are used for pruning them.

1.
2.
3.
4.

3. Pick two of these crops that interest you and describe how, and when they should be pruned.

-
-

Self-Reflection

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

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

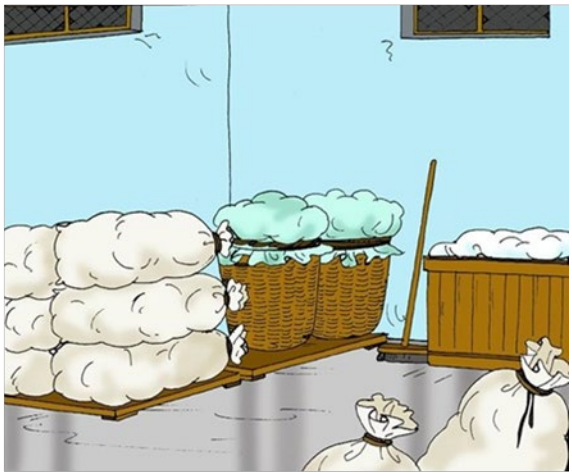
My experience **Knowledge, skills and attitudes**	**I don't have any experience doing this.**	**I know a little about this.**	**I have some experience doing this.**	**I have a lot of experience with this.**	**I am confident in my ability to do this.**
List out tools, materials and equipment used in horticulture maintenance					
Perform irrigation technics in horticultural Crops production.					
Perform Weeding and hoeing in the field of horticulture crops					
Describe symptoms and damages caused by pests and disease					
Explain pesticide application process					
Identify pests and diseases symptoms and damages in horticultural crops					
Match correct pesticide for managing pests					
Describe types of fertilisers					
Choose fertilisers following criteria					

Make compost					
Apply fertilisers using recommended techniques					
Describe the purpose of pruning					
Identify tools and equipment for pruning					
Identify pruning objectives					
Select tools and equipment					
Perform pruning technique					

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

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

Unit 3: Assist in harvesting activities



Topics

3.1 Maturity indices determination of horticultural crops

3.2 Performing harvesting operations

3.3 Packing and transport of horticultural crops produce

Unit Summary:

This learning unit will provide you the knowledge and skills you need to determine maturity indices of horticultural crops, perform harvesting operations, and pack and transport horticultural crops produce.

Self-Assessment: Unit 3

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

2. Fill in the self-assessment below.

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

My experience **Knowledge, skills and attitudes**	**I don't have any experience doing this.**	**I know a little about this.**	**I have some experience doing this.**	**I have a lot of experience with this.**	**I am confident in my ability to do this.**
Identify the types of maturity in horticultural crops production.					
Determine maturity of horticultural crops.					
Perform measurement of horticultural crops production.					
Select tools and equipment.					
Apply harvesting techniques.					
Perform postharvest field storage for horticulture crops.					
Select packaging material for horticulture produce.					
Select the packing methods.					

Perform transport of horticulture produce.					

Topic 3.1: Determine maturity indices of horticultural crops

Key Competencies

Knowledge	Skills	Attitudes
1. Describe types of maturity	**1.** Identify the types of maturity in horticultural crops production	**1.** Responsible
2. Describe ways to determine maturity indices	**2.** Determine maturity of horticultural crops	**2.** Methodical
3. Describe measurement parameters	**3.** Perform measurement of horticultural crops production	**3.** Practical

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

Topic 3.1 Task 1:

1. Look at the illustration.

2. Reflect upon the following:
   a. What do you think might be happening in the illustration?

   b. Use this image to help you remember back to the food crop production module and the learning outcome that dealt with determining maturity.

   c. What do you remember from that unit?

   d. What will you apply to horticulture crop maturity?

Problem Solving Activity

Topic 3.1 Task 2:

1. Read the following scenario and answer the questions with a partner:

   Rukundo and Uwimana are farmers who have grown tomatoes in a nursery and a crop of carrots in a ½ hectare field. They have recently harvested their tomatoes and plan to harvest their crop of carrots soon. They had planned to sell the tomatoes at the local market while selling the carrots to a distant buyer; however, just two days after the harvest, they noticed that most of their tomatoes were already overripe and unsuitable for consumption. Therefore, they proceeded to harvest and sell the carrots in order to cover their losses. Two weeks later they discover that their neighbour who also planted the same amount of carrots received a significantly greater amount of money for their harvest."

2. What do you think when wrong with Rukundo and Uwimana's crop during this growing season?

3. What could help them to produce better crops for next season that will ultimately earn them more money?

3.1 Key Facts

Types of maturity: Physiological maturity (fruits) vs Horticultural maturity (vegetables)

Physiological maturity: The stage of development when a plant part will continue development even if detached. Usually used in reference to fruit ripening.[29]

Stages:
- Immature
- Mature
- Ripening
- Ripe
- Overripe

Horticultural maturity: The stage of development when a plant possesses the necessary characteristics for use by consumers. Usually used in reference for vegetables.[30]

Stages:
- Immature
- Mature
- Overripe

Factors affecting maturity:
- Temperature
- Soil
- Size of planting material
- Spacing
- Pruning intensity
- Girdling, also called ringbarking, is the complete removal of a strip of bark in order to grow larger fruits

Importance of correct maturity:
- Sensory and nutritional quality
- Maturity determines if the produce will be sold for fresh market or processed food
- Adequate shelf-life
- Facilitate marketing standards

[29] Cantwell, M. (2014, June). *Maturation and maturity indices: When to harvest?*. UC Davis Postharvest Technology. https://ucanr.edu/datastoreFiles/234-2711.pdf
[30] Cantwell, M. (2014, June). *Maturation and maturity indices: When to harvest?*. UC Davis Postharvest Technology. https://ucanr.edu/datastoreFiles/234-2711.pdf

- Productivity: Under matured produce can lead to less volume. Over matured/ripened produce often leads to loss

Crop	Planting date	Maturity indices	Maturity (days)
Tomatoes	Jun-Sep &	Green colour turning pink to red ripe, firmness, size	45-60days
Carrots	Oct-Feb	Size, firmness, colour bright orange,	60-70days
Cabbages	Jan-Mar & Sept-Nov	Green colour, size, firmness, solidity	40-60days
Eggplant	Dec-Feb & Sept-Oct	Desirable size reached but still tender	90-120days
Avocadoes	Mar- April	Smoother skin surface and skin becomes dulled	4 to 14 weeks, depending on cultivar and environmental conditions
Pineapples	April-May	Surface colour changes from green to yellow to reddish-brown. NOTE: Pineapple fruit should be harvested at the height of ripening because they will not ripen further after being cut from the plant	90-120 days depending on cultivar and environmental conditions

Guided Practice Activity

Topic 3.1 Task 3

In small groups, you will practice measuring and determining the maturity of different horticulture crops. Your trainer will provide 3 different groups of produce of varying degrees of maturity. Complete the tables below answering the following questions:

1. What is the produce?

2. What kind of maturity type is the produce (e.g. Horticultural or Physiological) and at what stage is it (e.g. mature, immature, overripe)?

3. How can you tell the maturity i.e. what maturity indices are used?

4. How long has it been since the produce was planted?

Group A

Crop	Maturity type & Stage	Maturity indices	Estimated days since planting

Group B

Crop	Maturity type & Stage	Maturity indices	Estimated days since planting

Group C

Crop	Maturity type & Stage	Maturity indices	Estimated days since planting

Application Activity

Topic 3.1 Task 4:

Your task is to keep a horticulture journal where you can follow the growth cycle of a specific crop that interests you.

1. Each week measure the plants from the school garden or in cooperation with a local nursery or farm.

2. Determine what indices and how you will measure these plants.

3. Record all other processes related post planting maintenance.

4. Include additional notes regarding the condition of the plants.

5. Follow the format of the example give below.

Example:

Horticulture Journal: Tomatoes 2019 (2nd growing cycle)			
Date	**Maturity description:**	**Maintenance**	**Other notes**
11/06	● indicator 1 Colour- dark green ● indicator 2 Size-small fruits, average circumference=2cm ● indicator 3: Firmness- very firm	● Earthing up, pruning and done today. ● Fertilization done two days ago, June 9th	● Plant is healthy ● Fruits are on track
18/06			
25/06			

Points to Remember

- Physiological maturity is used to determine fruits.
- Horticultural maturity is used to determine vegetables.
- Size, shape, colour, and firmness are all good indicators to determine maturity.

Formative Assessment

1. Name the two types of maturity used in horticultural crop production and what they refer to.

1.

2.

2. Describe how you would measure the maturity of two horticultural crops that interest you.

Topic 3.2: Perform harvesting operations

Key Competencies

Knowledge	Skills	Attitudes
1. Classify tools and equipment	**1.** Select tools and equipment	**1.** Careful
2. Describe harvest techniques	**2.** Apply harvesting techniques	**2.** Attention to detail
3. Describe post-harvest field storage operations for horticulture crops	**3.** Perform postharvest field storage for horticulture crops	**3.** Practical

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

Topic 3.2 Task 1:

Look at the illustrations and reflect on the following:

1. What are farmers they wearing and holding?

2. Do you recognize the produce?

3. What do you think the farmers in the illustration and images are doing?

Problem Solving Activity

Topic 3.2 Task 2:

With a partner, read the following scenario and answer the questions below:

The KOABIBIKA cooperative, located in Karongi district is seeking workers to assist in their harvesting operations. The cooperative's land is expansive and the produce to be harvested includes eggplant, tomatoes and passion fruits crops within different field planted horticultural crops. You have decided to apply for this job.

1. Before you travel to the cooperative, prepare for the job interview by brainstorming some questions that may arise and show you are qualified for the job.

2. How might different crops require different harvesting techniques in the field? Make a list of all the different methods you can think of.

3. Make a list of tools will you need to help harvest these crops.

3.2 Key Facts

Harvesting tools and materials:

- Ladder
- Baskets
- Burlaps sacks
- Crates and bins
- Hand sickle
- Harvesting knife
- Hand saw
- PPE
- Spade
- Pitchfork

Harvesting techniques:

- **Fruit:** Should be harvested by using the palm of the hand, not by holding the fruit with the fingers. Whenever possible, the harvesting should be carried out by plucking the stem.
- **Leafy vegetables:** Harvest by cutting the plant with a sharp knife as close to the root as possible.[31]

Crops	Methods	Time since transplant	Optimal Yield
Tomatoes	Hand harvesting	65-85 days	15-20tons/ha
Carrots	Uproot by hand, with the help of pitchfork and spade	60-80 days	17-20tons/ha
Cabbages	Cut stem with knife, hand saw, or sickle	80-120 days	80,000-100,000 heads/ ha
Eggplant	Cut stem with knife or sickle	70 days	7-10tons/ha
Avocadoes	Hand harvesting prevent fruit from falling	8 months	20tons/ha
Pineapples	Cut fruit stalk with knife or sickle	15-18 months	8-12t/ha
Passion fruit	Hand harvesting	70- 80 days	15-20 tons/ha

[31] Dixie, G. (2005). *Horticultural marketing: Chapter 8: Post-harvest handling*. Food and Agriculture Organization of the United Nations. https://www.fao.org/3/a0185e/a0185e0a.htm

Time of day:

- Harvesting should take place when the crop and the climate are coolest, and the plant has the highest moisture content.
- Early morning, optimal however labour and transport may not be available early in the morning.
- If transport is a problem, the harvest should be rescheduled to avoid produce being left standing in the field for too long.

Post-harvest field storage:

- Bags or baskets attached to the waist of the picker enable both hands to remain free.
- The crop damage associated with moving sacks of produce through the field is thus reduced.
- When using bags, it is preferable to be able to release the bottom so that the produce can be let out gently, rather than upending the bag.
- Containers must be emptied carefully to minimize drop heights and fruit-to-fruit damage.
- Containers should be cleaned as often as possible.
- Keep harvested produce out of sun.[32]

Additional notes:

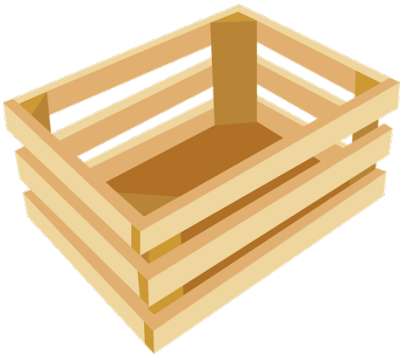
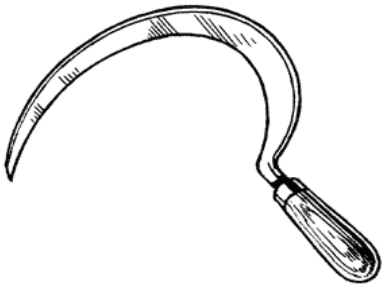
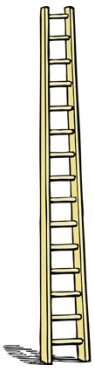
- Tomatoes should be picked leaving the sepal or green leaf on top of the fruit to help with ripening.
- Stack pineapples upside-down on their leafy tops to avoid damage
- Always make sure that harvesting tools are clean to prevent produce contamination

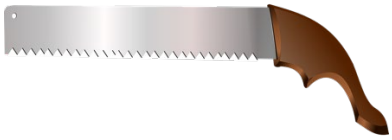
[32] Dixie, G. (2005). *Horticultural marketing: Chapter 8: Post-harvest handling*. Food and Agriculture Organization of the United Nations. https://www.fao.org/3/a0185e/a0185e0a.htm

Guided Practice Activity

Topic 3.2 Task 3:

Match the harvesting tools and materials required for each crop listed below.

a. 	**b.** 
c. 	**d.** 
e. 	**f.** 
g. 	**h.** 

i.	j.
	

1. Pineapple: _____

2. Tomatoes: _____

3. Avocadoes: _____

4. Cabbage: _____

5. Passion Fruit: _____

6. Eggplant: _____

7. Carrots: _____

Application Activity

Topic 3.2 Task 4:

In groups, your class will now perform harvesting and postharvest field operations for the horticulture crops growing in the school garden or in cooperation with a local farm or nursery. Within your groups, be sure to perform the following:

a. Select the necessary tools and equipment

b. Harvest different crops using the correct methods for each.

c. Preform post-harvest handling and field storage of the crops to minimize damage.

[33] All images are from Pixabay.com; License: https://pixabay.com/service/license/

d. Clean and sterilise tools upon completion.

Points to Remember

- Always make sure that harvesting tools are clean to prevent produce contamination
- The best time of day to harvest horticulture crops is early in the morning

Formative Assessment

Choose two horticulture crops that interest you and explain the different steps you would need take in order to harvest both correctly. Use the points below to aid in your discussion.

- Selecting tools
- Techniques and methods
- Time of day
- Field storage

Topic 3.3: Pack and transport horticultural produce

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe criteria for selecting packaging materials	**1.** Select packaging material for horticulture produce	**1.** Analytical
2. Describe packing methods	**2.** Select the packing methods	**2.** Precise
3. Describe the ways of transport methods of horticulture produce	**3.** Perform transport of horticulture produce	**3.** Careful

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

Topic 3.3 Task 1:



[34]

[34] All photos are from Pixabay.com; License: https://pixabay.com/service/license/

1. Look at the images and illustration above and reflect on the following:
   a. Have you ever had to package or transport horticulture crops?

   b. If so, which crops were they and how did you do it?

   c. Think back to the module that about food crop production and the learning unit that dealt with packaging and transportation. What can you recall?

   d. How might the packaging and transportation of horticulture crops be similar to that of food crops?

   e. How might it be different?

Problem Solving Activity

Topic 3.3 Task 2:

1. In groups read the scenario below and answer the questions that follow:

   Kalisa and Anet are the produce farmers who have just harvested several fields of horticulture crops. Their yields include 18 tons of carrots, 5 tons of tomatoes and 2 tons of pineapple and 3,000 heads of cabbage. However, they have not planned for how to transport or package the produce.

2. Your task is to draw up a plan for transporting Kalisa and Anet's produce by brainstorming the following:
   a. What problems could occur to their produce if they do not arrange for transportation quickly?

   b. What problems could happen if they choose poorly suited packaging for their harvest?

   c. What would you need to know before you could decide the right packaging materials and mode of transportation?

3. After brain storming and sharing with the class your group should make a plan for how the produce should be packaged and moved from the field.

3.3 Key Facts

Postharvest handling: The stage of crop production immediately following harvest, including cooling, cleaning, sorting and packing.[35]

Packaging fresh fruits and vegetables: One of the more important steps in the long and complicated journey from grower to consumer. Temperature and humidity are used to control shelf-life of commodities in refrigerated cold stores.[36]

Appropriate relative humidity is important to control the following:

- Water losses
- Decay development
- Incidence of some physiological disorders

Uniformity of ripening:

- Measure for relative humidity can be determined using a hygrometer.
- Proper relative humidity for horticulture produce should be 85-95% for the majority of the fruits, 95-98% for vegetables.
- Optimum temperature varies from 18 to 25˚C.
- At lower temperatures, ripening is slowed.
- From 25 to 30˚C ripening may be inhibited, and decay accelerated.

Selecting packaging methods for horticulture produce considerations:

- Functions of packaging
- Packaging materials
- Criteria for selecting packaging materials
- Easy transport
- Easy to fill, assemble and close
- Ventilation
- Dimension suited for transport
- Availability
- Cost
- Suited for market demands

Convenient containers for handling marketing fresh produce:

- Bags
- Crates

[35] Wikipedia. (n.d.). *Postharvest*. Retrieved 2019, from https://en.wikipedia.org/wiki/Postharvest

[36] Boyette, M., Sanders, D. C., & Rutledge, G. A. (1996, September 1). *Packaging requirements for fresh fruits and vegetables*. NC State Extension Publications. https://content.ces.ncsu.edu/packaging-requirements-for-fresh-fruits-and-vegetables

- Reusable plastic containers (RPCs)
- Hampers
- Baskets
- Cartons/ corrugated containers (CCFs)
- Palletized containers

Advantages of packing horticulture crops:

- Protection from oxygen
- Positive control of the moisture content of the product
- Inhibits the growth of aerobic spoilage bacteria
- Longer shelf life for goods
- Reduces the post-harvest losses

Transport methods of horticulture produce:

- Modes of short distance transport: Wheelbarrows, Bicycles
- Modes of long-distance transport: Trucks

Factors affecting produce quality during transport:

- Initial quality
- Physical injury
- Mixed load
- Atmospheric composition
- Humidity and water loss
- Temperature

Horticulture transport and storage parameters:

Crops	Temperature range	Relative humidity
Tomatoes	70 to 75˚F	85 to 95%
Carrots	0–3°C	80%
Cabbages	0˚C	98-100%
Eggplant	5-9˚C	95-98%
Avocadoes	≥ 10˚C	85-95%
Pineapples	10°C	92-95%
Passion fruit	7°C to 10°C	90% to 95%

Guided Practice Activity

Topic 3.3 Task 3:

1. In groups make a plan for selling the produce you have harvested in your school's nursery by followings the instructions bellow:

2. Pick one horticulture crop that you have harvested in the previous learning unit and make a list of three different places where you believe the school's horticulture crops could be sold.

3. Try to think about where there would be a need for this produce (demand) and how it would require different transportation and packaging considerations depending on these different destinations.

4. Now make a plan of how you would package and transport this produce along the following guidelines:

a. How will you prevent the produce from being damaged during transport?

b. How easy are packages to move by one person?

c. Are they easy to fill, assemble and close?

d. Does the package allow for enough ventilation?

e. Are the dimensions of the storage suited for transport?

f. Are the packages available in your area?

g. What is the cost of each package?

h. Are the packages suited for market sale or will the produce need to be transferred into another package?

i. How much will transportation cost?

5. Prepare your plan and when you are finished share your plan with the rest of the class.

6. Your class will then vote on which plan and location is the most feasible for selling the produce and then use it for the next activity.

Application Activity

Topic 3.3 Task 4:

You will now prepare to package the horticulture produce that you have harvested in the school garden. Your trainer will set up packaging stations for each kind of produce.

1. In groups practice selecting suitable packaging for each type of fruit or vegetable and package the items.

2. Once everyone in your group has had a chance to try packaging the items and done it correctly, discuss suitable transporting methods for your packaged produce.

3. Then unpack the items and move to the next station.

4. Once everyone has had the change to practice packaging different kinds of produce refer to the plan the class voted for in the previous unit.

5. Package the selected produce according to the plan and prepare to send the produce to a market or produce buyer.

6. With the help of your trainer take all the necessary steps in getting the packaged produce to market and generate a profit for your class.

Points to Remember

- Proper relative humidity for horticulture produce should be 85-95% for the majority of the fruits, 95-98% for vegetables.

- Optimum temperature varies from 18 to 25˚C.

Formative Assessment

1. Name three criteria that determine packaging selection.
   -
   -
   -

2. Choosing two horticulture crops that interest you, demonstrate how they should be packaged according to the destination of your choice.
   1.

   2.

Self-Reflection

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

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

My experience **Knowledge, skills and attitudes**	**I don't have any experience doing this.**	**I know a little about this.**	**I have some experience doing this.**	**I have a lot of experience with this.**	**I am confident in my ability to do this.**
Identify the types of maturity in horticultural crops production					

Determine maturity of horticultural crops					
Perform measurement of horticultural crops production.					
Select tools and equipment					
Apply harvesting techniques					
Perform postharvest field storage for horticulture crops					
Select packaging material for horticulture produce					
Select the packing methods					
Perform transport of horticulture produce					

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

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

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