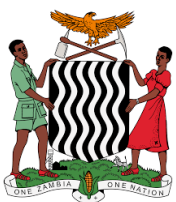


# ORGANIC VEGETABLE PRODUCTION MANUAL FOR TRAINERS

The Ministry of Agriculture  
Zambia Agriculture Research Institute  
Msekera Research Station  
Chipata, Zambia



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## DEVELOPMENT OF THIS TRAINING MANUAL

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## FOREWORD

This Vegetable Production Manual for trainers was produced under the Food and Nutrition Security, Enhanced Resilience Project (FANSER) in Zambia. FANSER has been initiated and commissioned by German International Cooperation (GIZ) on behalf of the German Federal Ministry of Economic Cooperation and Development (BMZ) as part of the Special Initiative “Transformation of Agricultural and Food Systems”. The initiative aims to address the challenges of hunger and malnutrition globally. As part of the national Scaling Up Nutrition process and the 1000 Most Critical Days Programme (MCDP) II, FANSER aims to improve the nutritional situation of women of reproductive age and children under the age of two years in six districts in Eastern and Luapula Provinces.

Food-based approaches to address micronutrient deficiency have gained global attention in research and development over the past decade. Under the FANSER Project, the production and consumption of nutrient-rich vegetables is a key vehicle being used to address Vitamin-A-Deficiency among women of reproductive age and children under the age of two years. Vegetables are among the cheapest and most important source of Vitamin A for small-scale farmers in Zambia. The nutritious vegetables such as Spinach, Chinese cabbage, Amaranthus, Rape, Mustard Spinach among others contain high level of Vitamin A and Iron with generally high yields. However, the average yields obtained by smallholder farmers are well below their potential.

With this manual, we want to encourage agricultural extension staff and trainers, who work with smallholder farming communities, women groups, etc. to continue the promotion of these highly nutritious vegetables as a contribution to Zambia`s fight against malnutrition.

Therefore, this manual has been developed to enhance information delivery and communication of vegetable production and post-harvest management practices for agricultural extension officers. They will be able to draw on this reference material in order to achieve increased vegetable productivity and nutritional-health benefits, particularly for women of reproductive age and young children in agro-ecological region one and two of Zambia. It is envisaged that this manual will be handy for all agricultural extension officers and trainers who work to improve vegetable production and reduce Vitamin A and Iron Deficiency.



Dr Heike Hoeffler

Food and Nutrition Security Coordinator GIZ, Zambia

## ACRONYMS

<b>FANSER</b>	Food and Nutrition Security, Enhanced Resilience
<b>GIZ</b>	Deutsche Gesellschaft für Internationale Zusammenarbeit
<b>MCDPII</b>	1000 Most Critical Days Program
<b>MoA</b>	Ministry of Agriculture
<b>SOA</b>	Sustainable Organic Agriculture
<b>ZARI</b>	Zambia Agricultural Research Institute



## INTRODUCTION

This organic vegetable training manual has three (3) modules and serves as a step-by-step guide to the organic vegetable production training for smallholder farmers supported by the Food and Nutrition Security, Enhanced Resilience (FANSER) project and beyond. The FANSER Project in Zambia is implemented by *Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)* under the “One World – No Hunger” Initiative of the German Federal Ministry for Economic Cooperation and Development. It aims at improving the nutritional situation of food and nutrition insecure people, particularly women of reproductive age (15 - 49) and children under the age of two years, within Eastern and Luapula Province of Zambia. The project supports the Zambian Government in reducing stunting among children under the age of two years under the 1000 Most Critical Days Program (MCDPII).

This Organic Vegetable training manual will assist facilitators to train farmers to establish and maintain home gardens to increase dietary diversity and improve the overall nutrition of their household members. The guide briefly outlines the various methods to be used during the training and the participatory adult learning techniques which are required for successful training. The guide is designed to be participatory (to bring out the experiences of farmers), practical (applicable to everyday agricultural realities) and experiential (to bridge theory with hands-on practice). It helps facilitators to follow the basic principles for adult learning to facilitate optimal learning and help participants to put the learned content into practice.

## HOW TO USE THIS TRAINING GUIDE

This manual has been structured in a way to achieve maximum participation of all learners in the learning sessions. Working groups should be voluntarily formed based on mutual interest in the subject. The facilitator of the training is not supposed to be a lecturer, but to facilitate in order to enhance the sharing of information among the participants. It is important that the facilitator motivates all participants and encourages them to share their experiences and take part in discussions and practical lessons.

The manual uses different types of methodologies for delivering the training content to the target group in order to effectively facilitate adult learning. The icons on the left side of the pages indicate the different steps and types of methodological techniques used during the adult learning process.

## ICONS FOR METHODOLOGICAL TECHNIQUES



### LEARNING OUTCOME

The facilitator clearly explains the objectives of the training to the participants.

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### DURATION

The facilitator mentions how long the lesson will take.

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### TRAINING MATERIALS AND TOOLS

All the training materials and tools are made available in advance to effectively deliver the training.

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### DISCUSSION

The facilitator initiates and guides discussions by asking questions and encouraging participants to share their knowledge, opinions, views or experiences.

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### GROUP WORK

The facilitator guides participants to form groups for discussions and exercises.

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### PRESENTATION

The facilitator asks the groups to make presentations after group discussions or exercises.

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### PRACTICAL EXERCISE

The facilitator leads and guides participants to carry out practical exercise demonstrate on the lessons covered.

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### LESSON SUMMARY

Participants share the key points learnt and the facilitator summarizes the lesson.

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**Note to the Facilitator:**

**At the start of every lesson, it is good practice for the facilitator to do the following:**

- *Welcome the participants to the training lesson on the particular topic.*
- *Set up the ground rules in order to have a smooth delivery of the lesson.*
- *Do a recap of the main content of the previous lesson.*
- *Explain what the focus of the lesson will be.*
- *Encourage participants to share their experiences and expertise openly.*

**At the end of each lesson the facilitator should:**

- *Allow the participants to ask questions to clarify or make any contributions.*
- *Ask participants to share highlights of what they have learnt during the lesson and how they will use it (small doable actions).*
- *Consolidate and summarize the discussion.*
- *Thank the participants for their participation and end the session.*

## OVERVIEW OF THE TRAINING MANUAL

This manual is intended to be a trainers' guide on organic vegetable production targeting smallholder farmers. The manual consists of 14 lessons which are organized to last half a day each.

LESSON	TIME FRAME	DAYS
<b>MODULE ONE: Sustainable soil fertility and natural pest and disease management</b>		
1. Benefits of vegetable production and types of vegetables	1 hour 50 min	Half a day
2. Compost making and application	2 hours 50 min	
3. Manure tea making and application	2 hours 20 min	Half a day
4. Preventive measures for pests and diseases in vegetables	1 hour 20 min	Half a day
5. Recipe for natural pesticides	3 hours	
6. Pest and disease management in vegetable production using natural pesticides	2 hours	Half a day
<b>MODULE TWO: Introduction to vegetable production and general management practices</b>		
1. Establishment of a vegetable nursery	3 hours	Half a day
2. Management of vegetable nursery	3 hours 30 min	Half a day
3. Types of vegetable gardens and Transplanting of seedlings in the main field	2 hours 20 min	Half a day
4. Pruning and staking in tomato and eggplant production	2 hours 20 min	Half a day
<b>MODULE THREE: Harvesting and post-harvest handling of vegetables</b>		
1. Harvesting of vegetables from the garden	1 hour 20 min	Half a day
2. Processing, preservation and storage of leafy vegetables and onion	3 hours 10 min	
3. Processing, preservation and storage of tomato, eggplant and okra.	2 hours 20 min	Half a day
4. Seed extraction, preservation and storage of tomato, amaranthus, pumpkin and okra	2 hours 20 min	

# MODULE ONE: SUSTAINABLE SOIL FERTILITY AND NATURAL PEST AND DISEASE MANAGEMENT

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This module aims to equip readers and farmers with necessary skills and knowledge on benefits of vegetable production and types of gardens, sustainable soil fertility and natural pest and disease management. Soil fertility management in vegetable production is based on the underlying principle of on-farm nutrient recycling as opposed to the heavy reliance on external inputs. Practices for the management of soil fertility include use of compost, compost/manure tea and cultural practices such as crop rotation, intercropping, mulching, etc. Natural pest and disease management focuses on the preventive and curative methods used in principles of organic vegetable production.

This module has a total of six (6) lessons.

- Benefits of vegetable production and types of gardens
- Compost making and application
- Manure tea making and application
- Recipe for natural pesticides
- Preventive measures for pests and diseases in vegetables
- Pest and disease management in vegetables using natural pesticides

# LESSON 1: BENEFITS AND TYPES OF VEGETABLE PRODUCTION



## LEARNING OBJECTIVES

1. To understand the benefits of the home garden in daily lives of households.
2. To understand nutritional value of vegetables.
3. To know the types of vegetables.



## TIME

1 hour 50 minutes



## TRAINING MATERIALS AND TOOLS

- Flip chart
- Markers
- Pieces of paper

## STEP 1: INTRODUCTION (10 MINUTES)

### *Instructions for the facilitator:*

- Explain to the participants that today we shall focus on the benefits and types of vegetables produced.
- Methodology: Discussion in plenary
- Encourage participants to share their experiences and expertise openly.



## STEP 2: DISCUSSION ON BENEFITS OF VEGETABLE PRODUCTION IN PLENARY (60 MINUTES)

### *Instructions for the facilitator:*

- Ask participants to get into pairs with their neighbor and discuss the following questions on the benefits of vegetable production.
  - What are the benefits of producing vegetables?
  - What are the benefits of consuming vegetables?
  - What quantity of vegetables do you consume in a day?

- Invite up to 5 participants to share their points from the discussions and ask other participants to add. Record the answers on a flip chart or on a piece of paper.
- Allow the participants to ask questions and make contributions to the presentation
- Provide important information by giving a talk on the benefits of vegetable production while considering what was shared in the plenary. After the talk, invite participants to ask questions for clarification.

## BENEFITS OF VEGETABLE PRODUCTION

- For health benefits, individuals should be consuming 400g of fresh vegetables per day.



400 grams

**Figure 1: A measure of two cupped hands of vegetables is recommended for daily individual consumption**

- **Nutritive value** - vegetables are rich in the vitamins, minerals and roughage needed by the human body, hence they improve the nutritional status of people if prepared correctly and consumed in the right quantities.
  - Rape, Chinese cabbage, Spinach, Mustard spinach and Amaranthus are among vegetables cultivated for their leaves that are commonly used as relish to accompany the main staple food.
  - Leafy vegetables have been recognized as good sources of vitamins, dietary fiber, and minerals.
  - **Vitamins:** Leafy vegetables are rich in vitamin C and A which are necessary for good nutritional status of the human body and to fight nutrient deficient diseases such as rickets and scurvy. For example, vitamin C helps in boosting the immune system and prevents iron deficiency in the body and this prevents diseases including iron deficiency anemia.



**Figure 2: Leafy vegetables**

- Eggplants and impwa are a good source of vitamin B and C, calcium and iron while tomatoes are rich in Vitamin A and C. They are usually eaten fresh and are also important additions to other cooked vegetable dishes.
- Vitamin A helps to improve resistance to heart diseases, boosts the immune system and improves eye health. It furthermore reduces morbidity and mortality in pregnant women and lactating mothers and their infants under two.



**Figure 3: Tomatoes and eggplants**

- **Dietary fiber:** Consumption of higher levels of vegetable fiber results in reduced risk of cardiovascular diseases and possibly colon cancer.
- **Minerals:** Micronutrient elements (minerals) available in leafy vegetables include iron, calcium, zinc, magnesium and phosphorus are very important for human health, disease prevention, and wellbeing.
- **Household income generation** – vegetables are in demand as every household needs them. Households with surplus quantities can earn some income when sold. In fact, vegetables are more profitable than most field cash crops per unit area. However, most farmers do not engage



in vegetable production due to the unavailability of water in the dry season for irrigation purposes.

- **Environmental and soil health** – vegetables are used in a crop rotation system to reduce soil pathogens, and pest and disease invasions.
- **Pest and Disease Management** – some vegetables have special properties which can be utilised to formulate pesticides such as chillies, garlic etc.
- They offer an opportunity for off-season production – some vegetables can be produced in the dry season when the farmer is unable to grow rain-fed crops.
- Surplus vegetables can be fed to small livestock including rabbits and chickens which in turn provide protein for the households.



### STEP 3: DISCUSSION ON TYPES OF VEGETABLES IN PLENARY (30 MINUTES).

#### **Instructions for the facilitator:**

- Ask the participants in plenary to discuss the following questions below:
  - What kinds of vegetables do you grow?
  - What criteria do you use to choose a vegetable variety to grow in your area?
  - What other vegetables are you interested in growing in the future?
  - Where is your garden located and give a reason why you selected the mentioned site.
- Provide important information by giving a talk on the benefits vegetable gardening and types of gardens while considering what was shared in the plenary. After the talk, invite participants to ask questions for clarification.

## TYPES OF VEGETABLES

### **Classification according to the part of the vegetable consumed**

- Leaf vegetables – e.g., rape, cabbage, lettuce, mustard, spinach
- Fruit vegetables – e.g., tomato, eggplants, impwa, green pepper, green beans
- Root/tuber – e.g., carrots, beetroot, onion, garlic, ginger
- Flower – cauliflower
- Cucurbits/squashes – pumpkins, cucumbers, butternut

### **Selection of the variety**

Selection of a variety depends on:

- The season it is to be grown
- Tolerance to pests and diseases
- The days the variety takes to maturity, e.g., early maturity, late maturity, etc. is one of the important factors that must be kept in mind before buying seeds.
- Adaptability: should be adapted to local ecological condition.

### **The classification according to the growing season**

- Cool season vegetables: these are vegetables which do well when grown in winter such as cabbage, garlic, onion, spinach, lettuce, potato and carrot.
- Warm season vegetables: these are vegetables which do well when grown in summer such as tomato, okra, eggplant and pumpkins



### **STEP 4: SUMMARY (10 MINUTES)**

#### ***Instruction to the facilitator:***

- Ask participants to share what they found most interesting about what they learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.
- Thank the participants for their participation and end session

# LESSON 2: PROCEDURES FOR MAKING COMPOST AND APPLICATION



## LEARNING OBJECTIVES

1. To know how to make compost and application



## TIME

2 hours 50 minutes

## TRAINING MATERIALS AND TOOLS



- Handout on the procedure of compost making for the participants
- Hoe
- Shovel
- Wheelbarrow
- Axe
- Manure (cow dung, poultry dung etc.)
- Stick
- Dry materials - Maize stalks, grass, groundnut haulms, crop residues of soyabeans, cowpeas, etc.
- Green materials – fresh leaves of *Gliricidia*, *tithonia*, *comfrey*, etc.
- Lime or ash
- Topsoil
- Water

## STEP 1: INTRODUCTION (10 MINUTES)

### **Instructions to the facilitator:**

- Recap the main points from the previous lesson
  - What do you remember from the previous lesson?
  - Ask if there is anything that needs to be clarified from the previous lesson
- Methodology: Discussion in plenary and practical exercise
- Explain that today we shall focus on compost making.



## STEP 2: DISCUSSION IN PLENARY ON COMPOST MAKING PROCESS (30 MINUTES)

### ***Instructions for the facilitator:***

- Ask participants the questions below in plenary for discussion and record on the flip chart.
  - What is compost?
  - What kind of materials do you usually use?
  - How do you make compost?
  - What is the favorable period of making compost?
- In case the participants do not know the answers, the facilitator should provide important information by giving a talk on compost making while considering what was shared in plenary. After the talk, invite participants to ask questions for clarification.

## **WHAT IS COMPOST?**

- Compost is a mixture of organic materials decomposed by microorganisms in a warm, moist, and aerobic environment, releasing nutrients into readily available forms for plant use.

## **THE IMPORTANCE OF COMPOST**

- Compost reduces the need for chemical fertilizers that are expensive and hazardous to the environment. Compost is used for conditioning and fertilizing the soil by the addition of humus, nutrients and beneficial soil organism. This helps improve the physical and chemical properties and contributes to enhancing the capacity of the soil to store air and water that facilitates plant growth.
- Compost also helps reduce the negative effects of the direct use of certain manures. For instance, the direct use of chicken manure is known to scorch the crop, while cattle manure, especially from animals on extensive grazing, is known to introduce weed seeds to the field.
- Manures from conventional farms normally contain toxic and unwanted substances such as growth hormones. The heat and the high microbial activity during the composting process normally helps to break down these unwanted substances.
- Composting also helps in the rapid release of nutrients from materials that otherwise take too long to decompose, e.g., maize stalks, dry grass, etc.

## **PERIOD OF COMPOST MAKING**

- Compost can be made throughout the year where rainwater is controlled and where materials are available. Select a level site preferably with some shade.

# RECOMMENDED MATERIALS FOR COMPOST MAKING

- **Course materials**

These are materials such as leguminous tree twigs, and crop stalks which are needed to facilitate aeration during composting.

- **Dry materials**

These are materials such as dry maize stalks, dry leguminous grass, saw dust, cowpea husks, groundnut husks, and rice husks which act as a source of carbon.

- **Green materials**

Green materials such as leguminous tree leaves, e.g., gliricidia, lecaena, groundnuts, cowpea, soybean, sun hemp etc. which activate microbial activity.

- **Animal manure**

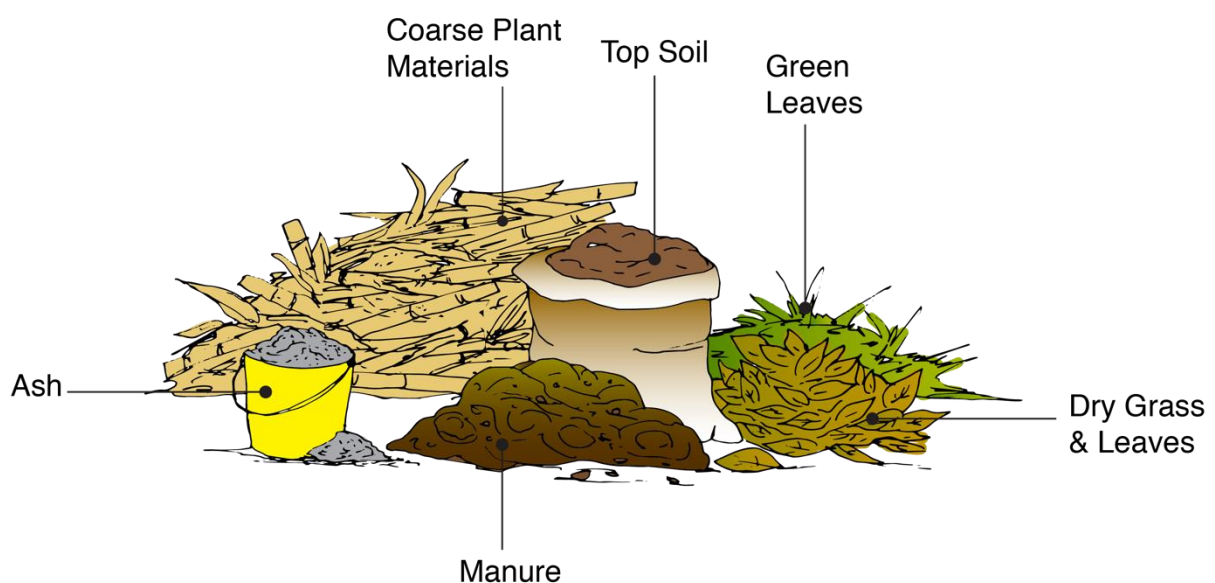
Well decomposed animal manure such as cow dung, goat manure, and chicken manure may be used as a source of nitrogen, phosphorus, potassium etc. They include leguminous tree twigs, and crop stalks which are needed to facilitate aeration during composting.

- **Water**

Water helps to cool down the temperature during decomposition hence providing favorable conditions for microbial activities.

- **Ash and soil**

The ash moderates the acidic conditions, and the soil helps to bind nutrients together and form a conducive growing medium.

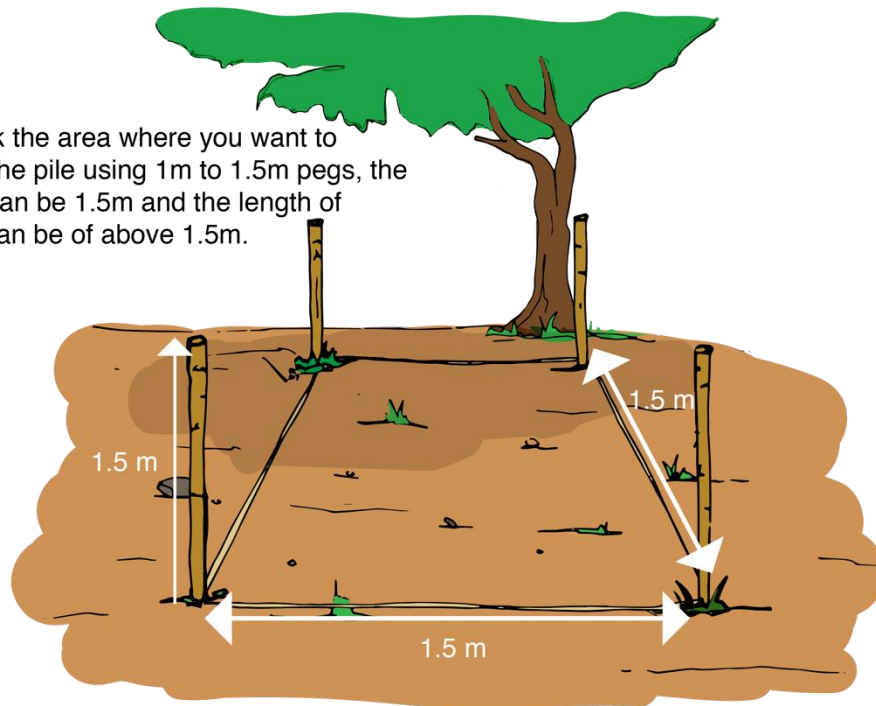


**Figure 4: Materials for compost making**

## PROCEDURE FOR COMPOST MAKING

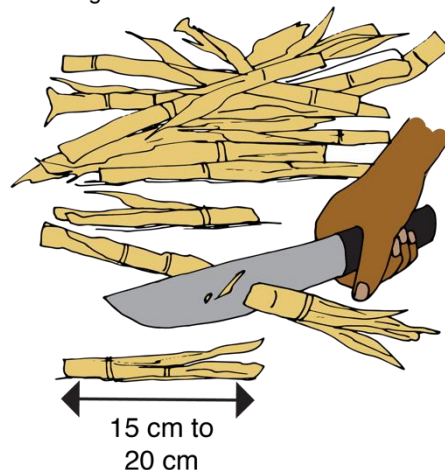
- Choose a site which is level and high enough to avoid rainwater from entering in the rainy season. It should also be near tree shade, thereby avoiding the direct sunlight which may raise the temperature
- Prepare the site by clearing it.
- Mark the area where you want to make the pile using 1 to 1.5m tall pegs, the length can also be 1m to 1.5m with a width of 1.5m to 2m

2. Mark the area where you want to make the pile using 1m to 1.5m pegs, the width can be 1.5m and the length of heap can be of above 1.5m.



**Figure 5: Marked area for compost making.**

3. Cut the larger materials such as maize stovers into 15 cm to 20 cm length



- Collect all the materials to be used in the compost pile (manure, cow or poultry dung, dry grass or maize stokers, green leaves such as gliricidia plant leaves, groundnuts, soybean and cowpea husks, ash and topsoil).
- Cut the larger materials such as maize stovers into 15cm to 20cm length or use maize cores if available

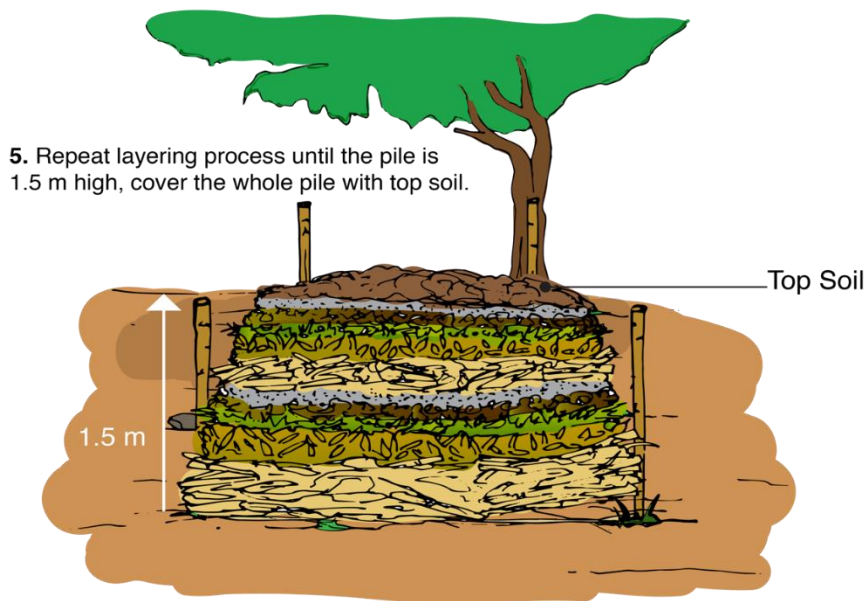
**Figure 6: Maize stovers cut in pieces for laying**

- **1st layer:** Lay the chopped materials (maize stovers or twigs) in a layer of 30cm thickness to allow aeration
- **2nd layer:** lay the dry materials such as leaves and grass to a thickness of 20cm and sprinkle with some water.
- **3rd layer:** the third layer will be green materials of a thickness of 10cm. Then place 5cm of manure on top, and apply 5kg of ash to control the ph.



**Figure 7: Layering of compost materials**

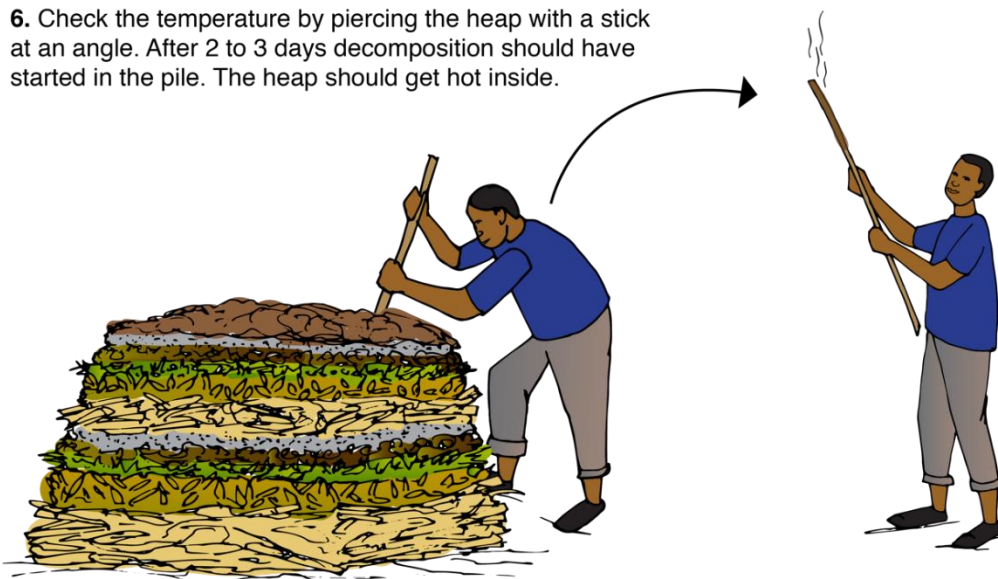
- Repeat steps 2 and 3 until the pile is 1.5m high, then cover the whole pile with topsoil. Remember to always apply water after laying of the dry materials.



**Figure 8: Compost pile covered with topsoil**

- Insert the dry stick in the compost pile at an angle after covering the whole pile with topsoil.
- The stick acts as a thermometer for measuring the wetness and dryness of the compost.
- Check the temperature of the heap with a stick which is inserted at an angle and 50cm deep, feel how warm it is after 2 to 3 days, if the stick feels hot, turn the composting materials and sprinkle some (20liters) of water. This will cool down the heap, but it will heat up again.

6. Check the temperature by piercing the heap with a stick at an angle. After 2 to 3 days decomposition should have started in the pile. The heap should get hot inside.



**Figure 9: Checking temperature of the compost heap**



7. The heap on the ground should be turned once every two months so that all the materials on the heap decompose evenly by allowing aeration.



**Figure 10: Farmer turning the compost**

- Do not allow the heap to dry out or mold will develop inside and spoil the composting process.
- In two to four months' time, your compost should be ready for use in the field depending on the materials used. Enough compost should be made for the whole farming season of the vegetable crop.

8. In two months time, your compost should be ready for use in the field and enough compost should be made for the whole farming season of the vegetable crop.



**Figure 11: Compost manure**

## APPLICATION OF COMPOST MANURE

- The amount of compost to apply depends on several different factors, including:
  - Soil fertility status – if soil has very low soil fertility, a farmer can apply a higher rate of compost.
  - The type of crop grown – some vegetable crops are heavy feeders (e.g., tomatoes, onion, spinach, etc.) while others are not (e.g., mustard spinach, amaranthus, chinese cabbage, etc.)
- During land preparation, it is important to mix enough compost with the soil before planting the seeds for nursery as well as before transplanting vegetable seedlings in the main field.
- **NOTE:** The frequency of application depends on the performance of the crop. Therefore, the farmers' own experience is key in determining when to apply and the rate of application.
- Besides use of compost in soil fertility management of vegetables, there are many other practices of soil fertility management that a farmer can use e.g., **bokashi, well-handled animal manure, green manures etc.**



### STEP 3: PRACTICAL EXERCISE ON HOW TO MAKE COMPOST (120 MINUTES)

#### **Instructions to the facilitator:**

- Identify the household in which to do the practical exercise on compost making beforehand. Make sure all the required materials and equipment are available in advance.
- Ask for volunteer participants who can demonstrate how to make the compost heap.
- Then ask the volunteer participants to demonstrate the compost making process. Encourage them to clearly explain the steps during the demonstration.
- Allow every participant to take part in the demonstration process.



### STEP 4: SUMMARY (10 MINUTES)

#### **Instructions for the facilitator:**

- Ask participants to share the highlights of what they learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.
- Thank the participants for their participation and end session.

# LESSON 3: MAKING MANURE TEA AND APPLICATION



## LEARNING OBJECTIVES

1. To know and understand the procedures for manure tea making and application.
- 



## TIME

2 hours 20 minutes

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## TRAINING MATERIALS AND TOOLS

- Well decomposed manure (cow dung or poultry manure etc.), leaves of nutrient-rich plants such as tithonia, comfrey, or leguminous plants such as gliricidia, velvet beans, moringa.
  - Drum
  - Porous sack
  - Stick and rope.
  - Water
- 

## STEP 1. INTRODUCTION (10 MINUTES)

### *Instructions for the facilitator:*

- Recap the main points from the previous lesson.
  - What do you remember from the previous lesson?
  - Ask if there is anything needing clarification from the previous lesson.
- Methodology: Discussion in plenary and practical exercise
- Explain to the participants that today we shall focus on making manure tea for vegetable production.



## STEP 2: LEAD A DISCUSSION IN PLENARY ON MANURE TEA MAKING PROCEDURES AND APPLICATION (30 MINUTES)

### ***Instructions for the facilitator:***

- Ask participants the questions below in plenary for discussions.
  - What do you understand manure tea is in your experience?
  - What is your experience in how to make manure tea?
  - What are the benefits of manure tea?
- In case the participants do not know the answers, the facilitator should provide important information by giving a talk to the participants on manure tea making while considering what was shared in plenary.

## **MANURE TEA**

- Manure tea is the extract of the manure of livestock, or leaves of nutrient rich plants being steeped in a porous bag submerged in water.
- Manure tea, just like compost, is used for the fertilization of different crops including vegetables.
- This is an organic alternative to chemical fertilizers and is a more sustainable practice of fertilization.

## **BENIFITS OF MANURE TEA**

- The manure tea, just like compost is used for the fertilization of vegetables. This is an organic alternative to chemical fertilizers and is a more sustainable practice of fertilization.
- As opposed to solid organic inputs such as manure or compost whose nutrient release is relatively slow, manure tea has an advantage of rapidly furnishing nutrients that are already solubilized to the crop.
- The process of making manure tea is relatively simple and can be done by any farmer.
- It should however be noted that manure tea cannot be used as a substitute for solid organic inputs. This is because the focus of manure tea, just like chemical fertilizers is to supply highly soluble nutrients to the crop. Manure tea does not contribute to the maintenance of soil organic matter. Therefore, manure tea should always be used as a supplement to solid organic inputs.

## **WHAT IS THE PROCEDURE FOR MAKING MANURE TEA?**

- Manure tea can be made from either compost, animal manures and green manure biomass, or a combination of two or all the above materials.
- Green manure biomass can come from plants such as velvet beans, Jack beans, and from agroforestry tree species such as, Moringa, Gliricidia and Tithonia)
- Having selected and decided on a suitable site, you can now follow the following step-by-step guide to make the manure extract:
  - Mobilize all the materials that are needed to make the manure/compost extracts.
  - Put about 30kg of dry manure/compost/desired leaves in a 50kg porous/grain bag.
  - Suspend the bag from a stick laid across the top of a 210 liters' drum/shallow well.
  - Fill the drum/well with water, the bag should be completely submerged in the water.
  - Shake the bag 2-3 times a day by moving the stick suspending the bag up and down for increased release of nutrients in the water and for aeration.
  - Cover the drum with a material that can keep out flies but allows aeration.
- Always keep the sack under the water
- The extract should be ready to use after 15 to 21 days.
- The residues of compost, manure or leaves in the sack can be used as input in the nursery.
- The manure tea should be applied directly on the soil around the plant through using a watering can or use of a container with holes on the base – bottom (1 part of manure tea to 4 parts of clean water).

## **APPLICATION OF MANURE TEA IN VEGETABLES**

- Manure tea can be applied as a foliar feed or directly to the soil around the plants. To use it as a manure tea, strain it well to remove solids, dilute it to the color of weak tea, and add it to a sprayer.
- Then just apply it to the top or undersides of the foliage on your garden plants.
- Generally, it is recommended to apply manure tea 2-3 weeks after germination and 4-5 weeks after transplanting for vegetables to improve the vigor and growth of the vegetable plants. The application can be done once per week in the dry season and twice per week in the rainy season.



**Figure 12: A farmer applying manure tea on growing vegetables**



**STEP 3: PRACTICAL EXERCISE ON HOW TO MAKE MANURE TEA (90 MINUTES)**

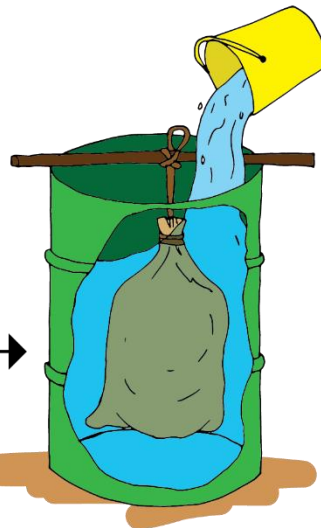
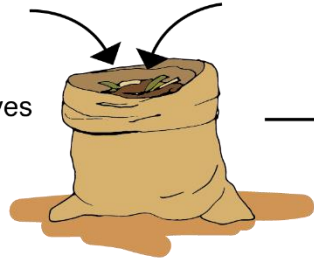
***Instructions for the facilitator:***

- Identify the site where to do the practical exercise on manure tea making beforehand. Make sure all the required materials and equipment are available in advance.
- Identify the participants who can demonstrate the procedure for making tea manure before the practical exercise.
- Before the practical exercise, the facilitator shows the illustrations on tea manure making procedures below to the participants and asks them the following questions while in the field to explain what they see in the picture.
  - What materials do you need to make manure tea?
  - What are the procedures/steps for making manure tea?
- Then ask the identified participants to demonstrate tea manure procedures.
- Allow every participant to take part in the demonstration process and ask questions for clarification.

1. Mobilize all the materials that are needed to make the manure tea/organic extracts



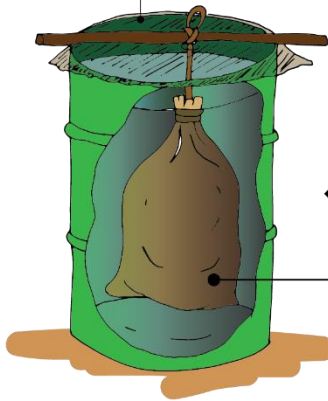
2. Put 1x 50kg bag equivalent to 30kg of manure/compost or leaves in a porous grain bag



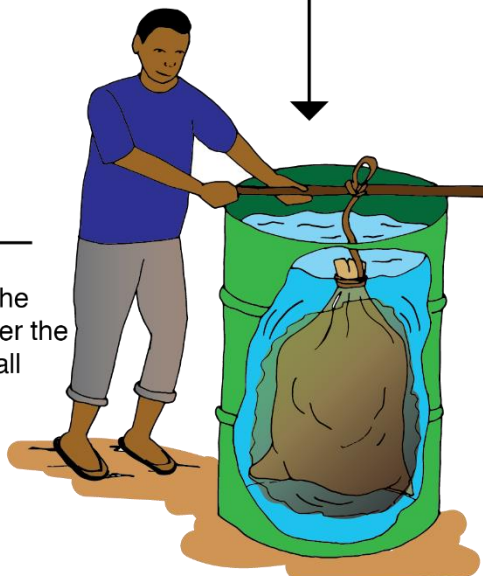
3. Suspend the bag from a stick laid across the top of a 210 litre drum/shallow well

4. Fill the drum/well with water, the bag should be completely submerged in the water

6. Cover the drum with a material that can keep out flies, but allows aeration



7. Keep the sack under the water at all times



5. Shake the bag 2-3 times a day by moving the stick suspending the bag up and down (for increased release of nutrients in water and for aeration)

7 to 15 days

8. Mix in the ratio of 4 buckets of water with 1 bucket of manure tea and apply directly on the soil around the plant through watering



9. Apply directly on the soil around the plant through watering



10. The residues of compost, manure or leaves in the sack can be used as input in the in the main field

Figure 13: Manure tea making procedures



#### STEP 4: SUMMARY (10 MINUTES)

***Instructions for the facilitator:***

- Ask participants to share what they found most interesting, about what they have learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.
- Thank the participants for their participation and end session.



# LESSON 4: PREVENTIVE MEASURES OF PESTS AND DISEASES



## LEARNING OBJECTIVES

1. To improve the skills of farmers in pest and disease preventive management of vegetables in the field.



## TIME

1 hour 20 minutes



## TRAINING MATERIALS AND TOOLS

- Flip chart or piece of paper
- Markers

## STEP 1. INTRODUCTION (10 MINUTES)

### *Instructions for the facilitator:*

- Recap the main points from the previous lesson.
  - What do you remember from the previous lesson?
  - Ask if there is anything to be clarified from the previous lesson.
- Methodology: Discussion in plenary and giving a talk.
- Explain to the participants that today we shall focus on preventive measures against pests and diseases in vegetables production.



## STEP 2: DISCUSSION AND TALK ON PREVENTIVE MEASURES OF PESTS AND DISEASE IN VEGETABLE PRODUCTION (60 MINUTES)

### *Instructions for the facilitator:*

- Ask participants the questions below to find out about their personal experience on preventive measures for pests and diseases in vegetable production and record the answers on the flip chart or piece of paper:
  - What common pests have you experienced in vegetable production?
  - What do you do to prevent them from attacking the vegetables?

- What common diseases have you experienced in vegetable production?
- What do you do to prevent them from attacking the vegetables?
- What are the advantages of using preventive measures to manage pests and disease?
- List all the answers mentioned in plenary on the flip chart. Make additions to what participants mentioned.
- Provide important information by giving a talk on preventive measures of pests and disease in vegetables in the field, taking into consideration the experiences that participants shared.

## THE COMMON PESTS IN VEGETABLES:

- Leafy vegetables: Aphids, Leaf miners, Bugrada bugs, Cutworms, Beetles, Diamond back moth and Melon fly.
- Onion: onion thrip
- Okra: Fruit African boll worms, aphids, red cotton bugs, nematodes, whitefly
- Tomatoes: Root knot nematodes, whitefly, red spider mites, American bollworms and Tuta absoluta
- eggplants: Diamondback moth,



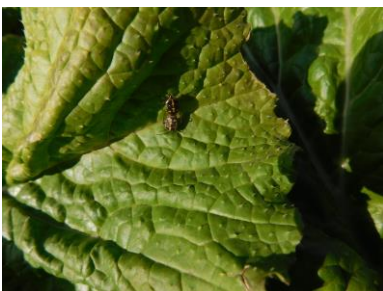
**Aphids**



**Leaf miners**



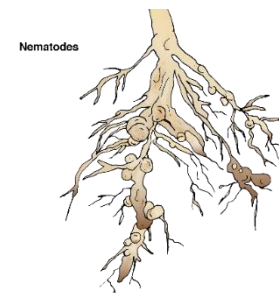
**Beetles**



**Bugrada bugs**



**Cutworms**



**Root Knot Nematode**

## COMMON VEGETABLE DISEASES

- **Leafy vegetables:** Peppery leaf spot, Black rot, Damping off, Downy mildew, Anthracnose.
- **Onion:** Purple Blotch and Black Blotch
- **Okra:** Powdery mildew and leaf spot
- **Tomatoes:** Early Blight, Late blight, Damping off, Powdery mildew, Fusarium wilt and Tomato yellow leaf curl
- **Eggplants:**
- Peppery leaf spot, Black rot, damping off, Downy mildew, Anthracnose and Mosaic viruses are some of the common diseases that affect leafy vegetables throughout the year.



**Peppery Leaf Spot**



**Black Rot**



**Powdery Mildew**



**Late Blight**



**Anthracnose**



**Mosaic Viruses**



**Early Blight**



**Fusarium Wilt**

# PREVENTIVE MEASURE FOR PESTS AND DISEASES IN VEGETABLES

## Biological control

- Biological control is the introduction of an organism which is a predator or parasite of the disease or pest into a crop area. Plants which attract predators and parasites can be interplanted with crop plants in alternate rows.
- Planting purple or yellow flowering plants in the garden, e.g., sun hemp and other ornamental flowering plants which attract predators such as ladybird beetles that feed on soft bodied pests such as aphids.

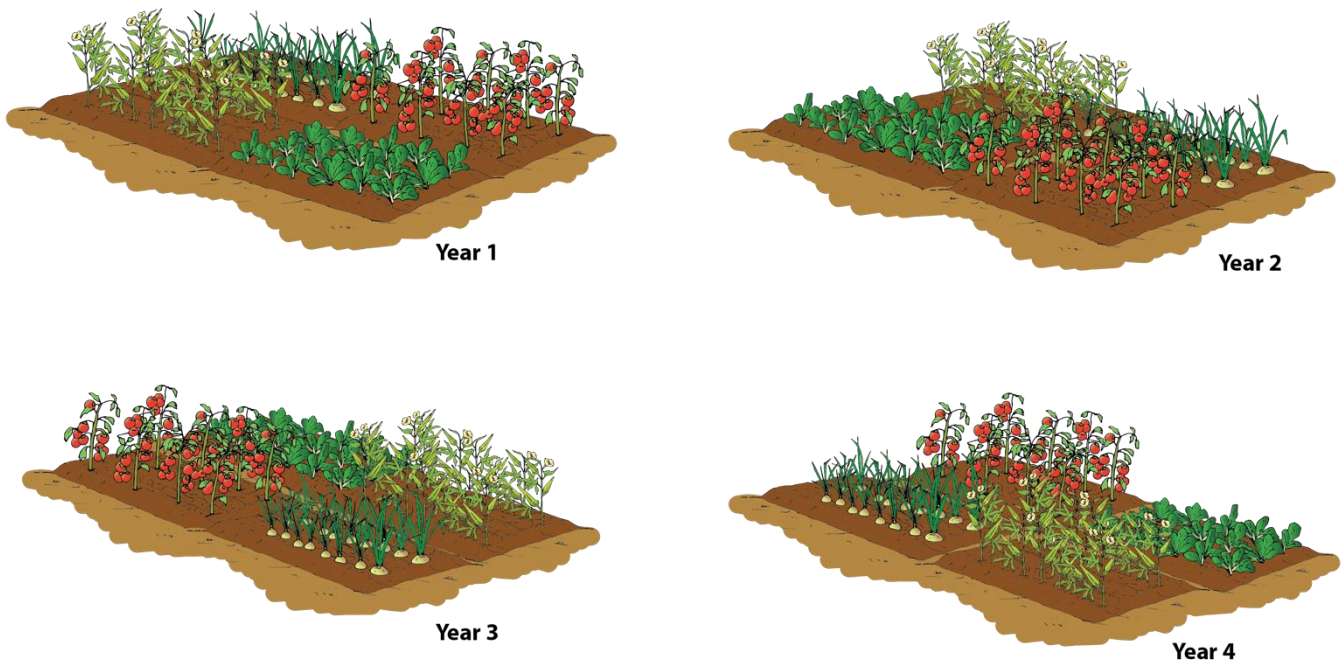
## Crop rotation

- Crop rotation is an essential part of preventing pests and diseases in the organic production of vegetables.
- The growing of the same or similar crops on the same piece of land year after year leads to the build-up of pests and diseases which transfer from one crop to the next. Hence vegetable crops should be rotated every year to avoid transfer of diseases.
- A rotation cycle of about 4 seasons is recommended for most vegetable crops.
- Knowledge of the crop type is essential in planning a viable rotation.
- Crop rotation is important in the following ways:
  - Improvement of soil structure (some crops have deep roots which can penetrate and break hardpan soil and tap moisture and nutrients from the ground).
  - Increased amount, diversity and activity of soil life as a result of the different types of organic matter added to the soil.
  - Weed control (planting different vegetable crops to break the cycle of the weeds).

## Important principles to consider when planning vegetable crop rotation.

- Besides weed, pest and disease control, crop rotation also plays a key role in soil fertility improvement and management. For example, the tomato is a heavy feeder crop and it can be

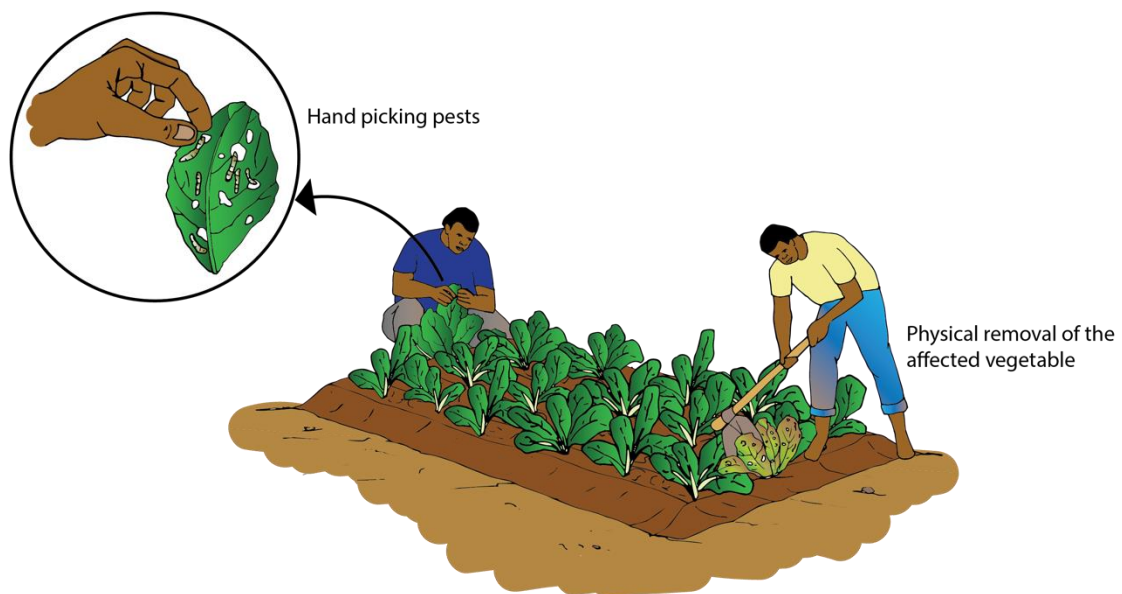
rotated with onion which is a light feeder. In this way the light-feeding onion doesn't deplete the soil, but gets what it needs, leaving sufficient nutrients for the tomato crop to benefit from.



**Figure 14: Crop rotation in vegetable production**

**Field hygiene and physical handpicking off pests and diseases plant parts.**

- Infected plant materials, alive or dead, when left in the field could pass pests and diseases to the next vegetable crop in the following season, hence, such debris should be removed and buried.
- The diseased vegetable plants and pests can also be removed physically by hand or handy hoes to avoid the spreading of diseases.



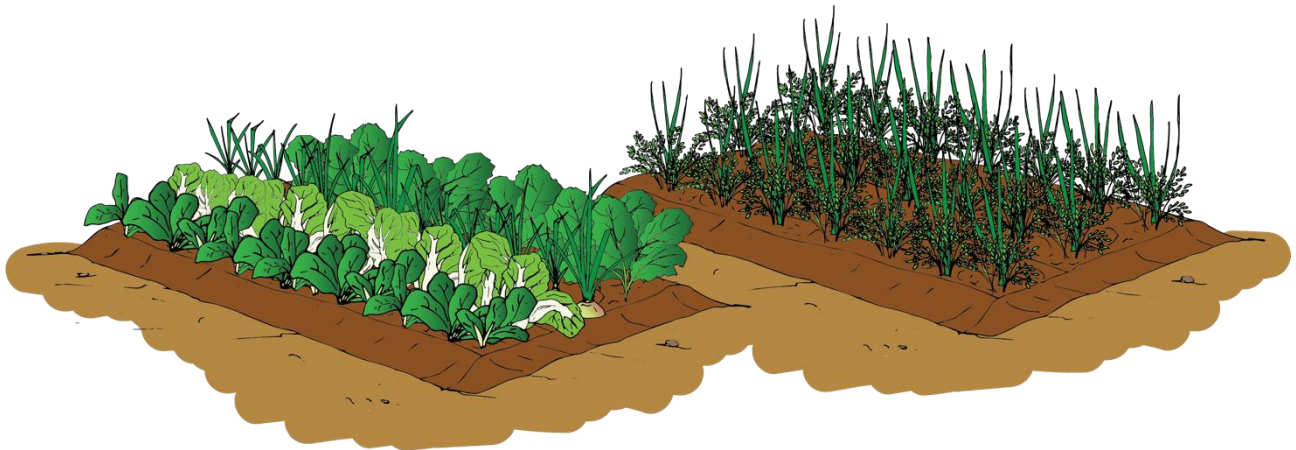
**Figure 15: Handpicking of pests and removal of diseased vegetables**

## Companion planting

- This is the growing of certain plants to protect other plants from pests and diseases. A good example is the intercrop between onion and leaf vegetables such as rape because onion has repellency effects – it deters aphids from attacking rape.
- Companion planting also involves growing non-crop plants such as marigold around vegetable crop plants for their pest deterring qualities.

## Intercropping

## Companion Planting



**Figure 16: Intercropping and companion planting in vegetables**

## Selection of tolerant varieties

- Different varieties of a crop may have different abilities to resist pests and/or diseases. For instance, traditional crop varieties grown by farmers have undergone natural selection over many years to become more adapted to local conditions and tolerate pests and diseases better than exotic ones.
- Crops which have been bred by modern methods tend to be very similar to one another (uniform) and as such have similar susceptibility to particular pests and diseases. Growing different varieties of the same crop as well as diversifying the number of crops in the field is an insurance against crop failure from pest and disease attacks and in unusual weather events such as droughts or floods.
- Additionally, growing different crops in the same field brings about diversity in the insect population as each crop attracts different types of insects. The diversity in the insect population is very important for ensuring that a balance between pest and predator is created.

## Social prevention

- At times it may be necessary to work with surrounding farmers to destroy a pest. For example, the variegated grasshopper usually has 1 or 2 nests per hectare. These can be destroyed by raking out the eggs from the nest and leaving them in the sun to dry out and die. The nest

could be on another farmer's field, but it could affect your crops. Joint action and cooperation between all farmers could considerably reduce infestation.

- **NOTE:** The above points about pest and disease management can be applied both in the nursery and in the main field.



#### STEP 4: SUMMARY (10 MINUTES)

***Instructions for the facilitator:***

- Ask participants to share what they found most interesting, about what they learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.
- Thank the participants for their participation and end session.

# LESSON 5: RECIPES FOR NATURAL PESTICIDES



## LEARNING OBJECTIVES

1. To know the recipes for natural pesticides
2. To understand the procedure for recipe formulation and application



## TIME

3 hours

## TRAINING MATERIALS AND TOOLS



- Flip chart
- Markers
- Traditional motor
- Ingredients (garlic, tobacco leaves, paw-paw leaves, chilli, neem leaves, Tephrosia leaves detergent paste and water)
- Strainer (cloth)
- Sprayer
- 5 buckets of 10L

## STEP 1. INTRODUCTION (10 MINUTES)

### *Instructions for the facilitator:*

- Recap the main points from the previous lesson.
  - What do you remember from the previous lesson?
  - Ask if there is anything to be clarified from the previous lesson.
- Methodology: Discussion in Groups, presentation and practical exercise.
- Explain to the participants that today we shall focus on recipes for natural pesticides for vegetable products.





## STEP 2: DISCUSSION IN GROUPS ON RECIPES PROCEDURES FOR NATURAL PESTICIDES (40 MINUTES)

### ***Instruction to the facilitator:***

- Divide the participants into two groups (A and B) and give them questions to discuss.
- Write the questions on the flip chart and give them the questions below for discussion:

#### Questions for group **A**

- What common pests and diseases do you know and which plants do they commonly attack? List them on the flip chart.
- What preventive measures can be applied to the mentioned pests and diseases in the question above?
- What organic substances can you use to control pests?

#### Questions for group **B**

- What organic substances can be used to prepare pesticides for disease management?
- How do you prepare organic pesticides?



## STEP 3: GROUP PRESENTATIONS FROM THE DISCUSSIONS IN PLENARY (40 MINUTES)

### ***Instructions for the facilitator:***

- Ask the group representatives to present the main content of their discussion. In case the participants don't know the name of the pests and diseases, they can describe them.
- Allow the participants to ask questions and make contributions to the presentation. Take note of the points on the flip chart or alternatively on a piece of paper.
- Consolidate and summarize the discussion from the presentation.
- Provide important information by giving a talk on recipes for natural pesticides by referring to the table and illustration below and while considering what was shared in the plenary. After the talk, invite participants to ask questions for clarification.

NO	TYPE OF SPRAY	PROCEDURE FOR FORMULATION	TARGET PESTS	TARGET DISEASES	CAUTION TO FARMERS
1	Pawpaw Spray	<ol style="list-style-type: none"> <li>1. Pound 1kg of pawpaw leaves</li> <li>2. Soak in 1 liter of water for 24 hours</li> <li>3. Add 50g of soap.</li> <li>4. Sieve through a cloth put in sprayer and then spray.</li> </ol>	Aphids and Leaf caterpillars.	Rust, Powdery mildew and blights	Do not consume any part of the plant for 3 days after spraying.
2	Chilli Spray	<ol style="list-style-type: none"> <li>1. Boil 4 cups of chilli in 3 liters of water for 15-20 minutes</li> <li>2. Add 3 liters of cold water and leave to cool.</li> <li>3. Sieve through a cloth, put in sprayer and spray.</li> </ol>	Ants, Aphids, Beetles, and Cabbage worm		May scorch plants if over sprayed
3	Tobacco Spray	<ol style="list-style-type: none"> <li>1. Soak 1kg of pounded tobacco leaves in 15 liters of water for 24 hours.</li> <li>2. Strain the mixture.</li> <li>3. Add one tablespoon of soap, put in sprayer and spray.</li> </ol>	Cutworms and Caterpillars	Rust, Blights, Powdery mildew, and Downy mildew	Do not consume any part of the plant for 3 days after spraying.
4	Neem Spray	<ol style="list-style-type: none"> <li>1. Pound 1kg of neem tree leaves</li> <li>2. Soak in 5 liters of water for 24 hours</li> <li>3. Add one tablespoon of soap.</li> <li>4. Sieve through a cloth, put in a sprayer and then spray.</li> </ol>	Diamond-back moth, Thrips, Aphids, Cutworms, Tuta absoluta, Mites, white flies, grasshoppers and beetles.		Do not consume any part of the plant for 3 days after spraying.
5	Tephrosia Vogelli Spray	<ol style="list-style-type: none"> <li>1. Pound 1kg of Tephrosia leaves</li> <li>2. Soak in 5 liters of water for 24 hours</li> <li>3. Add one tablespoon of soap.</li> <li>4. Sieve through a cloth, put in the sprayer and then spray</li> </ol>	Tuta absoluta, Bagrada bugs and Caterpillars.		Do not consume any part of the plant for 3 days after spraying.

### Recipes for natural pesticides



## STEP 4: PRACTICAL EXERCISE ON HOW TO MAKE RECIPES FOR NATURAL PESTICIDES (90 MINUTES)

### Instructions for the facilitator:

- Identify the site in which to do the practical exercise on preparation of natural pesticides beforehand. Select the recipes to be prepared beforehand as well. Make sure all the required materials and equipment for preparing the pesticides and fungicides are available in advance.
- Identify participants who can demonstrate the procedure for recipes for natural pesticides.
- Before the practical exercise, the facilitator should show the participants the below illustrations on recipe procedures for natural pesticides and ask questions to check they understand the pictures while at the site.
  - What are the steps for preparing the natural pesticide recipes?
- Allow every participant to take part in the demonstration process and ask questions for clarification.
- **NOTE:** 10g is equivalent to one full tablespoon of the powdered ingredient

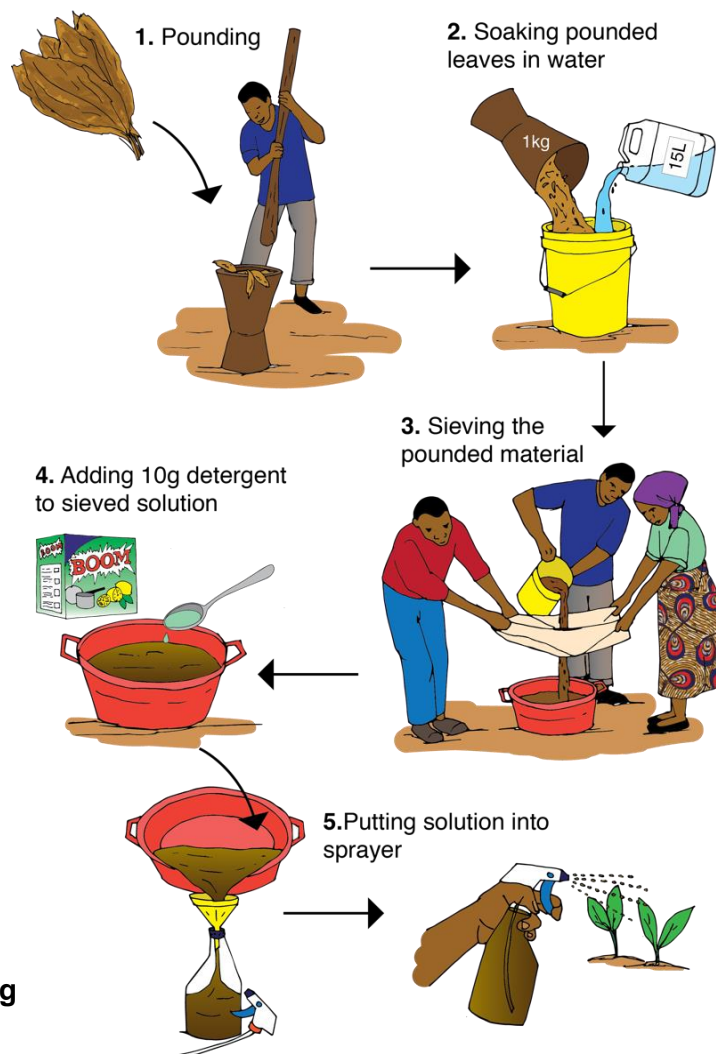


Figure 17: Steps for making natural substances



## STEP 5: SUMMARY (10 MINUTES)

### ***Instructions for the facilitator:***

- Ask participants to share the highlights of what they have learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.
- Thank the participants for their participation and end session.

# LESSON 6: PEST AND DISEASE MANAGEMENT IN VEGETABLES USING ORGANIC PESTICIDES



## LEARNING OBJECTIVES

1. To improve the skills of farmers in pest and disease management of leafy vegetables in the field using organic pesticides.



## TIME

2 hours



## TRAINING MATERIALS AND TOOLS

- Natural pesticides
- Sprayer
- Flip chart or paper
- Markers

## STEP 1. INTRODUCTION (10 MINUTES)

### *Instructions for the facilitator:*

- Recap the main points from the previous lesson.
  - What do you remember from the previous lesson?
  - Ask if there is anything to be clarified from the previous lesson.
- Discussion in groups, presentation and practical exercise
- Explain to the participants that today we shall focus on pest and disease management in leafy vegetables using organic substances.



## STEP 2: DISCUSSION IN GROUPS ON PEST AND DISEASE MANAGEMENT IN VEGETABLES USING ORGANIC PESTICIDES (30 MINUTES)

### ***Instruction to the facilitator:***

- Refresh their memories of common pests and diseases from previous lessons.
- Divide the participants into two groups. Ask one group to answer the questions on pests and the other group on diseases using the questions below:
- **Questions on pests**
  - What are the common pests that attack leafy vegetables? List them.
  - What natural pesticides do you use which are effective for each pest mentioned?
  - How often do you spray pesticides in order to manage the pests?
- **Questions on diseases**
  - What are the common diseases that affect leafy vegetables? List them.
  - What natural pesticides do you use which are effective for each disease mentioned?
  - How often do you spray pesticides in order to manage the diseases?



## STEP 3 GROUP PRESENTATION ON PESTS AND DISEASES IN VEGETABLE PRODUCTION USING ORGANIC PESTICIDES (30 MINUTES)

### ***Instructions for the facilitator:***

- Ask the group representatives to present the points from their discussion on pests and disease management using natural substances in vegetable production.
- Allow the participants to ask questions and make contributions to the presentations.
- Provide important information by giving a talk on pests and diseases in vegetable production while considering what was shared in the plenary. After the talk, invite participants to ask questions for clarification.

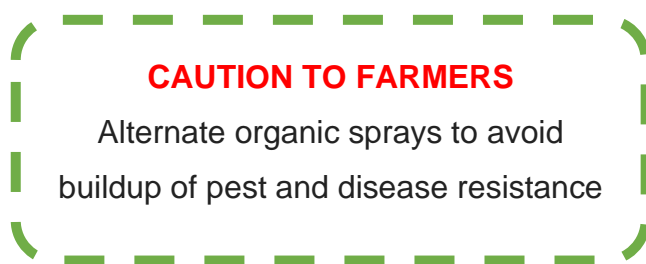
## **THE COMMON PESTS IN VEGETABLES:**

- Leafy vegetables: Aphids, Leaf miners, Bugrada bugs, Cutworms, Beetles, Diamond back moth and Melon fly
- Onion: onion thrip
- Okra: Fruit African boll worms, aphids, red cotton bugs, nematodes, whitefly
- Tomatoes: Root knot nematodes, whitefly, red spider mites, American bollworms and Tuta absoluta
- Eggplants: Diamondback moth

**PLEASE NOTE:** For the pictures of the pests and diseases, refer to the lesson on preventive measures against pests and diseases in vegetable production.

## ORGANIC PEST MANAGEMENT

- Spray natural pesticides at least once per week in the dry season and twice per week in the rainy season at 150mls/10m<sup>2</sup>.
  - Neem or garlic spray (onion thrips, nematodes, whitefly, bollworm)
  - Chilli spray (aphids)
  - Tobacco spray (aphids, caterpillars)
  - Snake bean or marigold spray (cutworm, bollworm)
  - Wood ash sprinkle (red cotton bugs in okra, nematodes)
  - Spray with Lantana solution, (effective for aphids, leaf miner, blister beetles)
  - Tephrosia spray (tuta absoluta, red spider mites)



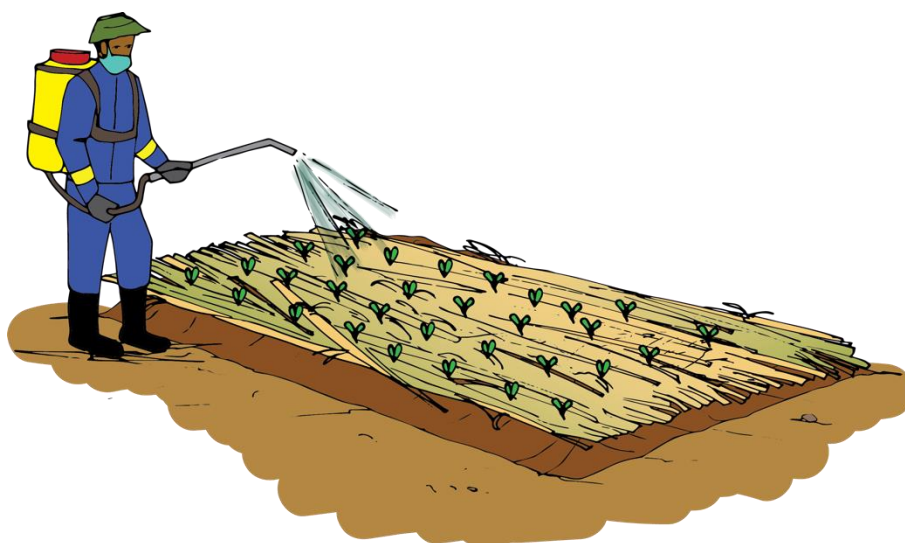
## COMMON DISEASES OF VEGETABLES

- **Leafy vegetables:** Peppery leaf spot, Black rot, Damping off, Downy mildew, Anthracnose.
- **Onion:** Purple Blotch and Black Blotch
- **Okra:** Powdery mildew and leaf spot
- **Tomatoes:** Early blight, Late blight, Damping off, Powdery mildew, Fusarium wilt and Tomato yellow leaf curl
- **Eggplants:** Diamondback moth
- Peppery leaf spot, Black rot, damping off, Downy mildew, Anthracnose and the Mosaic viruses are some of the common diseases that affect leafy vegetables throughout the year.

## ORGANIC DISEASE MANAGEMENT

- Spray natural fungicides at least once per week in the dry season and twice per week in the rainy season, this is due to the fact that these are contact pesticides which are easily washed away by rainfall and are effective when the spraying frequency is increased.
- The spraying is done the same way as in the grown vegetables.
  - Paw paw spray (leafy vegetables)

- Tobacco spray
- Cow urine and sour milk (half a liter of cow urine and half a liter of sour milk in 9 liters of water)
- Neem or garlic spray (onion thrips, nematodes, whitefly, bollworm)
- Chilli spray (anthracnose, early blight)
- Tobacco spray
- Snake bean or marigold spray (late blight, early blight)
- Wood ash sprinkle (red cotton bugs in okra, nematodes)
- Spray with soapy lantana solution, (effective for aphids, leaf miner, blister beetles)
- Tephrosia spray (tuta absoluta, red spider mites)



**Figure 18: Spraying vegetables with natural pesticides**



**STEP 4: PRACTICAL EXERCISE ON APPLICATION OF ORGANIC PESTICIDES FOR PEST AND DISEASE MANAGEMENT IN LEAFY VEGETABLES (50 MINUTES)**

***Instructions to the facilitator:***

- Identify the site in which to practice the application of organic pesticides in leafy vegetables for pests and diseases management beforehand.
- Identify participants who can demonstrate how to spray organic pesticides on leafy vegetables.
- Allow every participant to take part in the demonstration process and ask questions for clarification where needed.





## STEP 5: SUMMARY (10 MINUTES)

### ***Instructions for the facilitator:***

- Ask participants to share what they found most interesting, about what they learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.
- Thank the participants for their participation and end session.

# MODULE TWO: INTRODUCTION TO VEGETABLE PRODUCTION AND GENERAL MANAGEMENT PRACTICES

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This module is aimed at equipping readers and farmers with necessary skills and knowledge on establishment of nurseries and general management of vegetable production at both nursery level and in the main field. Farmers need to understand the principles of producing healthy seedlings for high productivity and profitability. The general management practices are a set of voluntary practices designed to maximize vegetable production.

This module has a total of four (4) lessons:

- Establishment of a vegetable nursery
- Management of the vegetable nursery
- Types of vegetable gardens and transplanting of seedlings in the main field
- Pruning and staking in for tomato and eggplant production

# LESSON 1: ESTABLISHMENT OF A VEGETABLE NURSERY



## LEARNING OBJECTIVES

1. To enhance the knowledge and skills of farmers in establishment of vegetables in the nursery.



## TIME

3 hours



## TRAINING MATERIALS AND TOOLS

- Hand hoes
- Well decomposed manure/compost
- Watering can
- Seeds
- Grass for mulching

## STEP 1. INTRODUCTION (10 MINUTES)

### *Instructions for the facilitator*

- Recap the main points from the previous lesson.
  - What do you remember from the previous lesson?
  - Ask if there is anything needing clarification from the previous lesson.
- Methodology: Group work, presentation and practical exercise.
- Explain to the participants that today we shall focus on establishing the nursery.



## STEP 2: DISCUSSION IN GROUPS AND PRESENTATION ON ESTABLISHMENT OF VEGETABLE NURSERIES (40 MINUTES)

### *Instruction to the facilitator:*

- Divide the participants into 4 groups of 4-7. Half of the groups are the group **As** and the other half are the group **Bs**.
- Write the questions on the flip chart and give them the questions below for discussion:

### *Questions for group A*

- What are factors to consider when choosing a site for vegetable nursery establishment?
- How are nursery beds prepared?
- How much manure is required during bed preparation for vegetable nursery establishment?

### *Questions for group B*

- What are the advantages of establishing a vegetable nursery?
- How do you plant the vegetable seeds in the bed?
- How often should vegetable nurseries be irrigated?
- How should mulching be done?
- Ask the group representatives to present the main content of their discussions.
  - Allow the participants to ask questions and make contributions to the presentation.
  - Consolidate and summarize the discussion from the presentations.
- Provide important information by giving a talk on vegetable nursery establishment while considering what was shared in the plenary. After the talk, invite participants to ask questions for clarification.

## **WHAT IS A VEGETABLE NURSERY?**

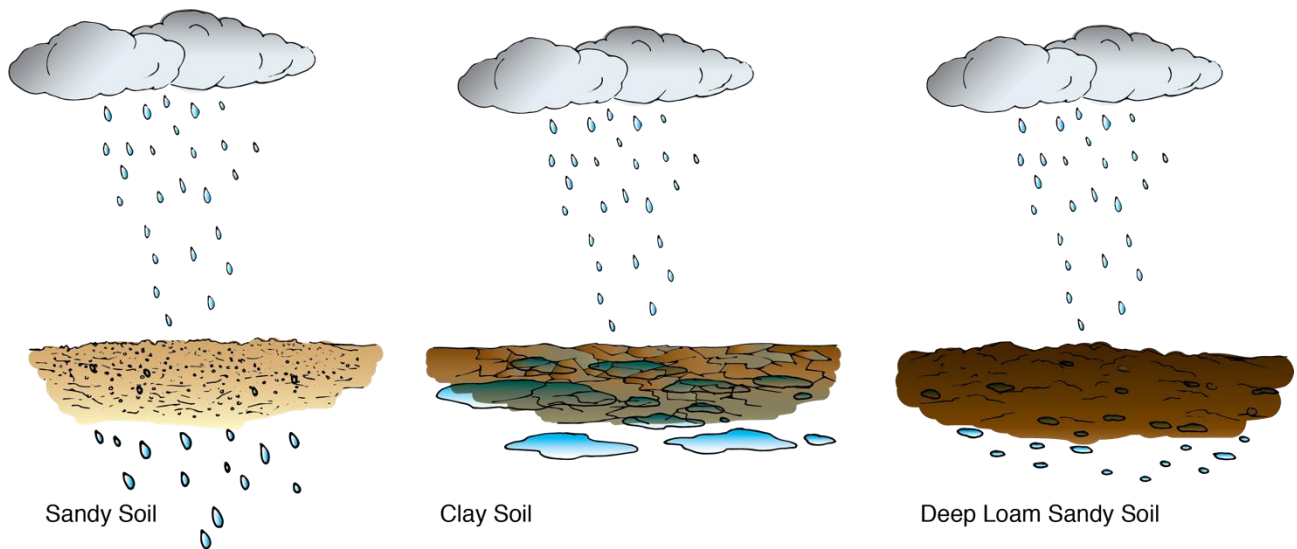
- The nursery is an area where plant seedlings are grown under special care and protection. Such a site must be well selected to avoid undue interference and to ensure that the seedlings raised are healthy.



**Figure 19: A vegetable nursery garden site**

## FACTORS TO CONSIDER WHEN SELECTING A GOOD SITE FOR A NURSERY

- **Type of soil**, the soils should be well drained, deep, fertile and preferably sandy loam which are friable and loose.



**Figure 20: Types of soils**

- **Security**, a fence should be erected for protection of the seedlings from theft and destruction by animals.
- **Location**, a nursery should be located close to production areas for ease of transport of the seedlings when transplanting.
- **Accessibility**, transplanting might be done during the rainy season, when roads are at their worst, so nurseries should be readily accessible by all-weather roads.
- **Climate**, the vegetable crop chosen should be adapted to the climatic factors in the nursery production site.
- **Access to water** is critical for watering the nursery.
- **Topography**, the best site should be on well-drained soils to avoid flooding and erosion through water runoff.
- **NOTE:** the same factors mentioned above apply when selecting land for production in the main (beds) field. Leafy vegetables tolerate a wide range of soils especially those with good drainage, mildly acidic soils and high amounts of organic matter. Rape, Chinese cabbage, Spinach, Mustard and Amaranthus do well in cool to warm weather conditions.

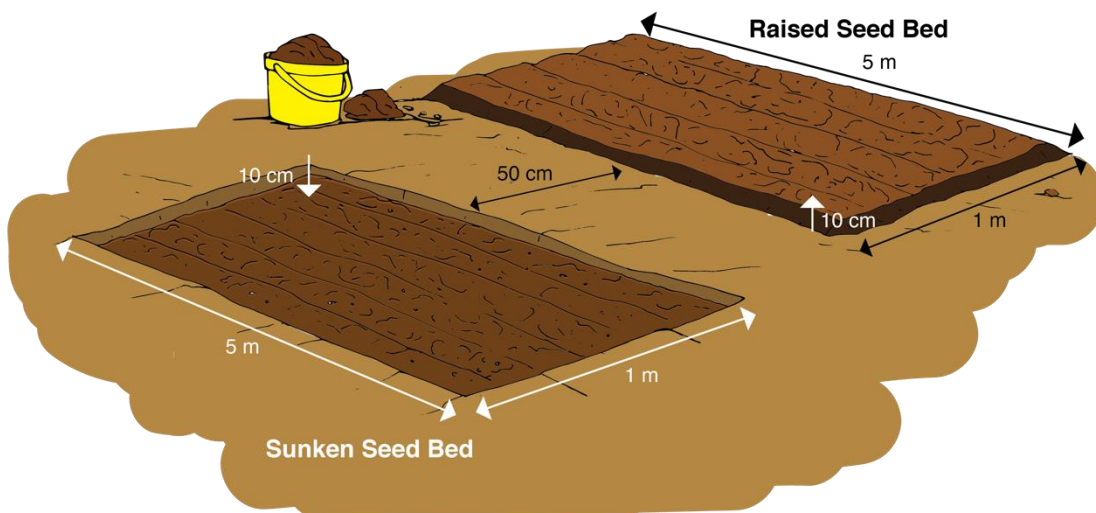
## LAND PREPARATION

- **Land clearing**, the site should be well cleared and avoid sites with big trees and shrubs to avoid shade over the seedlings. Where there are high incidences of soil-borne diseases like damping off and soil pests like nematodes, sterilizing the soil is necessary.



**Figure 21: Tilling of land for bed preparation**

- In sunny conditions, sterilization can be achieved by covering the area where the bed is to be made, with a black plastic leaving as little air underneath as possible, to build up enough heat to destroy any soil pathogens.
- A good seed bed is prepared by cultivating land to a depth of between 15cm to 20cm which is equivalent to the size of the palm of a hand from the tip of the middle finger to the base of the wrist, and then break the clods until you achieve fine friable tilth. The cultivation is normally followed by breaking clods into a fine friable tilth.
- A recommended maximum seedbed may be 5m x 1m or less depending on the quantity of seed to be planted. However, the width should always be 1m for easy management purposes.



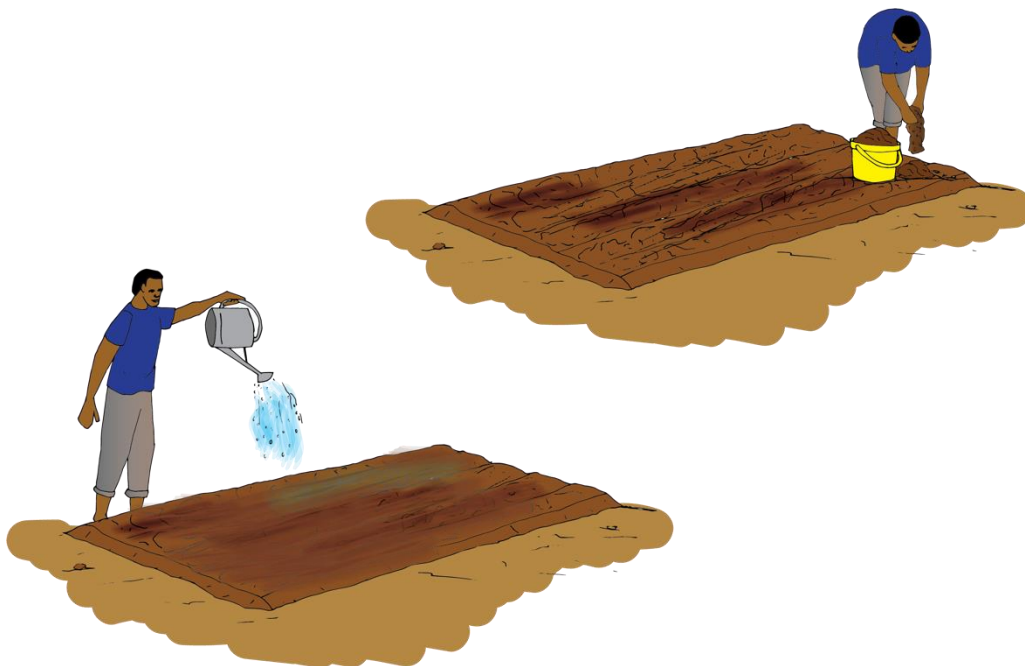
**Figure 22: Sunken and raised nursery beds**

- Manure or compost should be applied and mixed well with the soil before planting. This will improve the soil moisture holding capacity.
- Main beds which are sunken during the rainy season or raised during the dry season are recommended depending on the irrigation system to be used and the season of planting.
- To prevent contamination from the previous crops and reduce the build-up of soil-borne disease, the land used for other green leafy vegetable crops should not have any same species as in the previous production cycle.
- A **raised seed bed** can be prepared in the rainy season to drain off excess water while a **sunken seed bed** can be prepared in the dry season to conserve moisture.

**NOTE:** Land preparation is done similarly for planting in the main field.

## MANURE APPLICATION AND IRRIGATION

- Apply well-decomposed animal manure or compost at 2.5kg to 5kg (1-gallon container) in a 5m<sup>2</sup> (1m x 5m) area by incorporating it with soil before sowing depending on soil fertility.
- In the main field it is recommended applying the manure to the beds at least a week or two weeks before planting, depending on the soil fertility. This is to facilitate the thorough mixing of soils and manure or compost.
- The nursery beds require light irrigation using a watering can or a bucket in order to allow the seeds to germinate. At the time of planting / sowing light irrigation should be done soon after, especially if the moisture content is insufficient. The intervals for irrigation depend on weather and sufficiency of the moisture in the soil. On average it is important to irrigate at least at 3 - 5-day intervals.



**Figure 23: Manure application and watering for nursery establishment**



## ADVANTAGES OF ESTABLISHING A VEGETABLE NURSERY

- Vegetable nurseries encourage high germination of small, seeded vegetables such as rape and onion that would not germinate well if they were grown directly in the main field
- Raises high-quality, disease-free seedlings.
- There are reduced field management costs.
- Facilitates raising of delicate seeds and increase their chances of survival in the field and
- Attain relatively uniform plants in the main field.

## SOWING SEEDS INTO THE SEED BED

- Make shallow drills or sowing lines of 10cm to 20cm apart with a stick. Seeds are sown by drilling uniformly at 1cm to 2cm depth for most vegetable crops and then covering lightly with loose soil. Pressing the soil lightly with the palm is a good technique that ensures enhanced contact between the soil and seed and prevents the seed from being washed away during watering.
- The quantity of seed required in a 10m x 10m (100m<sup>2</sup>) area for Rape, Chinese cabbage, Spinach and Mustard is 5g.
- However, the quantity of seed required in a 10m x 10m (100m<sup>2</sup>) for Amaranthus is 20g. Amaranthus is usually sown directly in the main field at a spacing of 30cm x 20cm with two seeds per station other seeds can be broadcast.
- Rape, Chinese Cabbage, Spinach, Mustard and Amaranthus may be planted all year round but the best time to plant is during the cool to warm months (August to September).
- However, Amaranthus can be grown throughout the year, though the best performance is winter months (August to April).
- The nursery shouldn't be very close to the main field to avoid the spread of pests and diseases from the older vegetables.

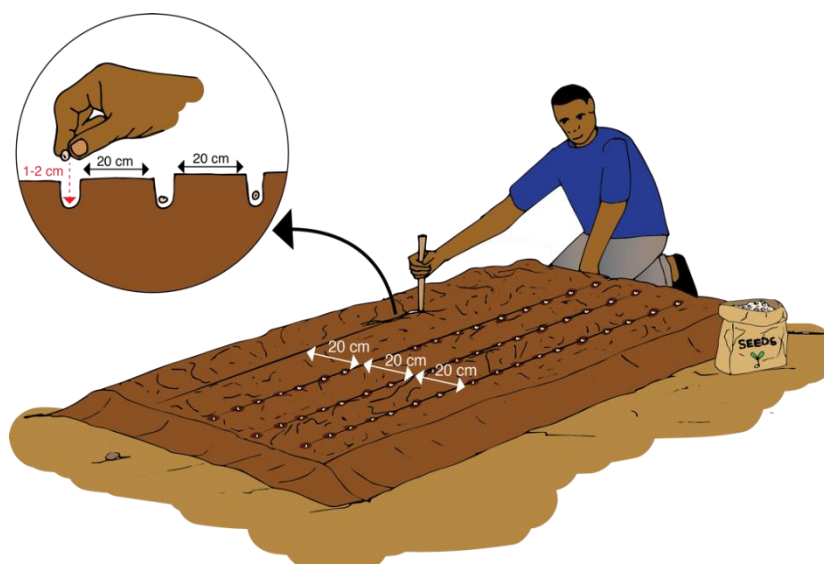


Figure 24: Farmer sowing seeds in a nursery bed

**NOTE:** Mulch the beds with grass after sowing to protect the seeds from direct sunlight and birds or animals. Mulch is discussed in more depth in the next lesson.



**Figure 25: A farmer applying mulch after sowing seeds in the bed**



**Figure 26 A farmer watering seeds in the bed after applying mulch**



**STEP 3: PRACTICAL EXERCISE ON VEGETABLE NURSERY ESTABLISHMENT: SITE SELECTION, BED PREPARATIONS, SOWING, IRRIGATION AND MULCHING (120 MINUTES)**

**Instructions to the facilitator:**

- Identify the garden site in which to conduct the practical exercise on vegetable nursery establishment.
- Identify participants with experience who can demonstrate how to choose the best site, nursery bed preparations, sowing of seeds, irrigation and mulching. Encourage them to clearly explain the steps during the demonstration.
- Allow every participant to take part in the demonstration process.



#### STEP 4: SUMMARY (10 MINUTES)

***Instruction to the facilitator:***

- Ask participants to share what they found more interesting about what they have learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.
- Thank the participants for their participation and end session.

# LESSON 2: MANAGEMENT OF VEGETABLE NURSERY



## LEARNING OBJECTIVES

1. To improve the skills of farmers in management practices for vegetables in the nursery including soil fertility, irrigation, weeding, thinning and mulching.



## TIME

3 hours 30 minutes



## TRAINING MATERIALS AND TOOLS

- Watering can
- Sprayer
- Hand hoes

## STEP 1. INTRODUCTION (10 MINUTES)

### *Instructions for the facilitator:*

- Recap the main points from the previous lesson.
  - What do you remember from the previous lesson?
  - Ask if there is anything needing clarification from the previous lesson.
- Methodology: Discussion in plenary, Giving a talk, Group discussion and Practical exercise.
- Explain to the participants that today we shall focus on the establishment of the nursery.



## STEP 2: DISCUSSION AND TALK ON SOIL FERTILITY MANAGEMENT AND IRRIGATION OF VEGETABLES IN THE NURSERY IN PLENARY (30 MINUTES)

### *Instruction to the facilitator*

- Ask participants about their own personal experiences with soil fertility management and irrigation of vegetables in nursery.
  - How do you manage soil fertility of vegetables in the nursery?
  - How often do you irrigate vegetable nurseries?
- In case the participants do not know the answer to the above question, the facilitator should provide important information by giving a talk on soil fertility management and irrigation while

considering what was shared in the plenary. After the talk, invite participants to ask questions for clarification.

## SOIL FERTILITY MANAGEMENT

- Regular application of manure tea optimizes growth and improves the health of the plants.
- Apply manure tea once every week. The manure tea is applied directly on the soil around the plant using a watering can. If the farmer does not have a watering can, he can use a homemade container with holes.
- Manure tea should be applied both on nursery plants after germination and in the main field.



**Figure 27: A farmer applying manure tea**

## IRRIGATION

- A nursery bed should be watered with fine droplets using a watering can or improved home watering container, preferably morning and evening depending on the soil type and conditions of the day.
- Watering can be reduced to once a day after germination. Most vegetables are shallow rooted unlike field crops. This means they require the frequent application of water.
- Generally, leafy vegetables such as rape, Chinese cabbage, spinach and mustard should be irrigated twice per day after transplanting so that they do not wilt as they establish themselves.
- Watering once per day is more desirable when the crop is established, however, the prevailing weather conditions will determine the amount of water for irrigation.
- Furrow, flood, cane/bucket irrigation and sprinkler irrigation methods may be used depending on soil type.



**Figure 28: A farmer watering the main bed**



**STEP 3: DISCUSSION IN GROUPS ON MULCHING, WEED CONTROL AND THINNING AND HARDENING OF VEGETABLES IN THE NURSERY (60 MINUTES)**

***Instruction to the facilitator:***

- Divide the participants into three groups (A, B and C) and write the questions below on the flipchart for them to discuss according to their group:

***Questions for group A***

- What is mulching?
- What material do you use for mulching?
- What are the benefits of mulching vegetables?
- How do you mulch vegetables in the nursery?

***Questions for group B***

- How do you manage weeds in vegetable fields?
- What are the advantages and disadvantages of weeds?

***Questions for group C***

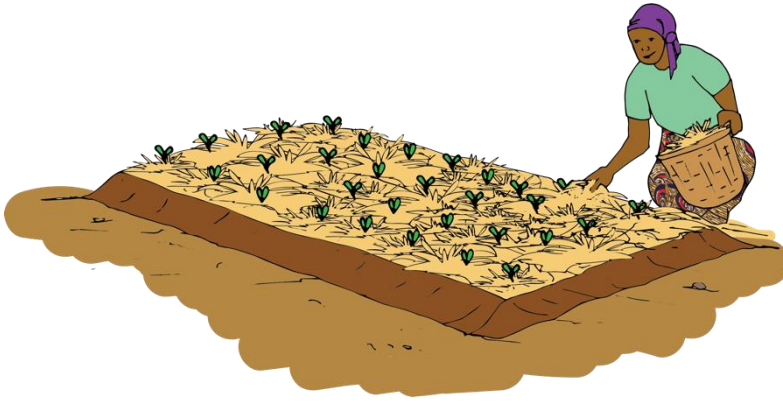
- What is thinning?
  - What are the advantages of thinning nursery vegetables?
  - What is the importance of hardening vegetable nurseries?
- Ask the group representatives to present the main content of their discussion and make notes of their points on the flip chart.
    - Allow the participants to ask questions and make contributions to the presentation.
    - Consolidate and summarize the discussion from the presentation.

- Provide important information by giving a talk on mulching, weed control, thinning and hardening for vegetable nursery management, while considering what was shared in the plenary. After the talk, invite participants to ask questions for clarification.

## MULCHING

- Mulching is a process of covering the surface of the soil with organic material, for example, compost or grass, or inorganic material and is a practice that brings many benefits to the soil and plants and can also help control pests and diseases. Crops can be planted through a mulch or have mulching material added later during crop growth.
- Mulching involves using dry grass; dry leguminous tree leaves or crop residues and applying this once the seedlings establish to reduce water loss and suppress some weeds, especially where water is scarce.
- The benefits of mulching include:
  - Mulch improves control of soil temperature and moisture. Mulching reduces the loss of moisture from the soil surface and reduces excess heat or cooling of the soil which is important for crops susceptible to extreme weather.
  - Mulch helps in suppression of weeds. It reduces competition from weeds as their ability to germinate under mulch is greatly reduced.
  - Mulch can disturb the life cycles of certain pests. For example, these may be prevented from reaching the soil. Blister beetles are discouraged from laying their eggs in soil which has been mulched.
  - Mulch increases soil humus content. All mulches from organic materials, even coarse ones, will eventually break down into the soil and contribute to the humus content which is so important for soil and crop health.
  - Mulch reduces soil erosion. As the soil is covered, it is protected from the erosive effects of wind and rain, thus reducing the amount of soil lost from fields. Water infiltration into the soil is improved.
- It is important not to use diseased material for mulch as this may infect the crop.
- Too much mulch prevents adequate air movement and encourages pests and diseases.

- It is advisable to keep a small gap between the stem of the plant and the mulch.



**Figure 29: A farmer applying mulch in the main field**

## WEED MANAGEMENT

- Weeding is necessary in the main field to avoid weeds competing for nutrients, sunlight, water and space and hence deter vegetable growth. To avoid this, hand hoe weeding is recommended.
- If not controlled, some weeds compete with vegetables for nutrients, water, light and may also harbour pests and diseases. However, some weeds can be beneficial in the following ways:
  - Bright flowers of some weeds can attract beneficial insects that prey on pests.
  - Provide the much-needed organic biomass that can contribute to soil fertility.
  - Nutrient recycling as some weeds are deep-rooted.
  - Provision of soil cover
- Weeds are typically removed manually, that is with hands.
- During the rainy season, weeding immediately after rain should be avoided as this would lead to transplanting the weeds. At the same time hand-weeding/hoe weeding when the soil is too dry is normally very tedious and might result in leaving the weed roots in the ground where they can re-sprout. Therefore, weeding should be done when the soil is neither too wet nor too dry.
- Once the vines have grown and covered the ground, there is little need for further weeding.
- Removing weeds in the field before they have formed seeds is an important weed control strategy for the next crop. This prevents the weeds from producing seeds that would germinate in the next cropping.
- Crop rotation and intercropping help prevent the build-up of weed populations. Mulching can reduce weed emergence significantly.





**Figure 30: A farmer weeding the main field**



**Figure 31: A farmer weeding in an onion field**



**STEP 4: PRACTICAL EXERCISE ON MANURE TEA APPLICATION, WEED CONTROL, THINNING, AND MULCHING IN THE MAIN FIELD IN VEGETABLE NURSERY PRODUCTION (100 MINUTES)**

***Instructions to the facilitator:***

- Identify in advance the site in which to conduct the practical exercise on vegetable nursery management practices: mulching, manure tea application, weeding and thinning.
- Then ask the identified participants to demonstrate how the above practices are done. Encourage them to clearly explain the steps during the demonstration.
- Allow every participant to take part in the demonstration process.



## STEP 5: SUMMARY (10 MINUTES)

### ***Instruction to the facilitator:***

- Ask participants to share what they found more interesting about what they learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.
- Thank the participants for their participation and end session.

# LESSON 3: TYPES OF VEGETABLE GARDEN AND TRANSPLANTING OF SEEDLINGS TO THE MAIN FIELD



## LEARNING OBJECTIVES

1. To know and understand the types of gardens for vegetable production.
2. To improve the skills of farmers in transplanting of vegetables.



## TIME

2 hours 20 minutes



## TRAINING MATERIALS AND TOOLS

- Watering cane
- Hand hoes/shovels
- Seedlings
- Flip chart

## STEP 1. INTRODUCTIONS (10 MINUTES)

### *Instructions for the facilitator:*

- Recap the main points from the previous lesson.
  - What do you remember from the previous lesson?
  - Ask if there is anything needing clarification from the previous lesson.
- Methodology: Discussion in plenary, Giving a talk and Practical exercise
- Explain to the participants that today we shall focus on types of gardens for vegetable production and transplanting in the main field.



## STEP 2: DISCUSSION AND TALK ON TYPES OF GARDENS FOR VEGETABLE PRODUCTION AND TRANSPLANTING TO THE MAIN FIELD (30 MINUTES)

### *Instructions for the facilitator:*

- Ask participants to discuss the following questions on types of gardens for vegetable production and transplanting of leafy vegetables and record the answers on the flip chart:

- Where is your garden located and give a reason why you selected the mentioned site?
  - When do you transplant/plant seedlings from the garden to the field?
  - How do you transplant/plant the leafy vegetables?
  - What precautionary measures do you consider when transplanting seedlings from the garden to the main field?
- List all the answers mentioned in plenary on the flip chart. Make additions to what participants mentioned.
  - Provide important information by giving a talk on types of gardens for vegetable production and transplanting vegetables to the field, while taking into consideration the experiences that participants shared.

## TYPES OF VEGETABLE GARDENS

- **Backyard gardens** - these are established within the homestead.
- **Dambo gardens** - are located in wetland areas or along streams.
- **Upland gardens** - are established in upland fields. These are either rain-fed or they use wells or bore holes.
- **Keyhole gardens** - is a circular raised garden bed with a centrally placed basket for watering and composting.

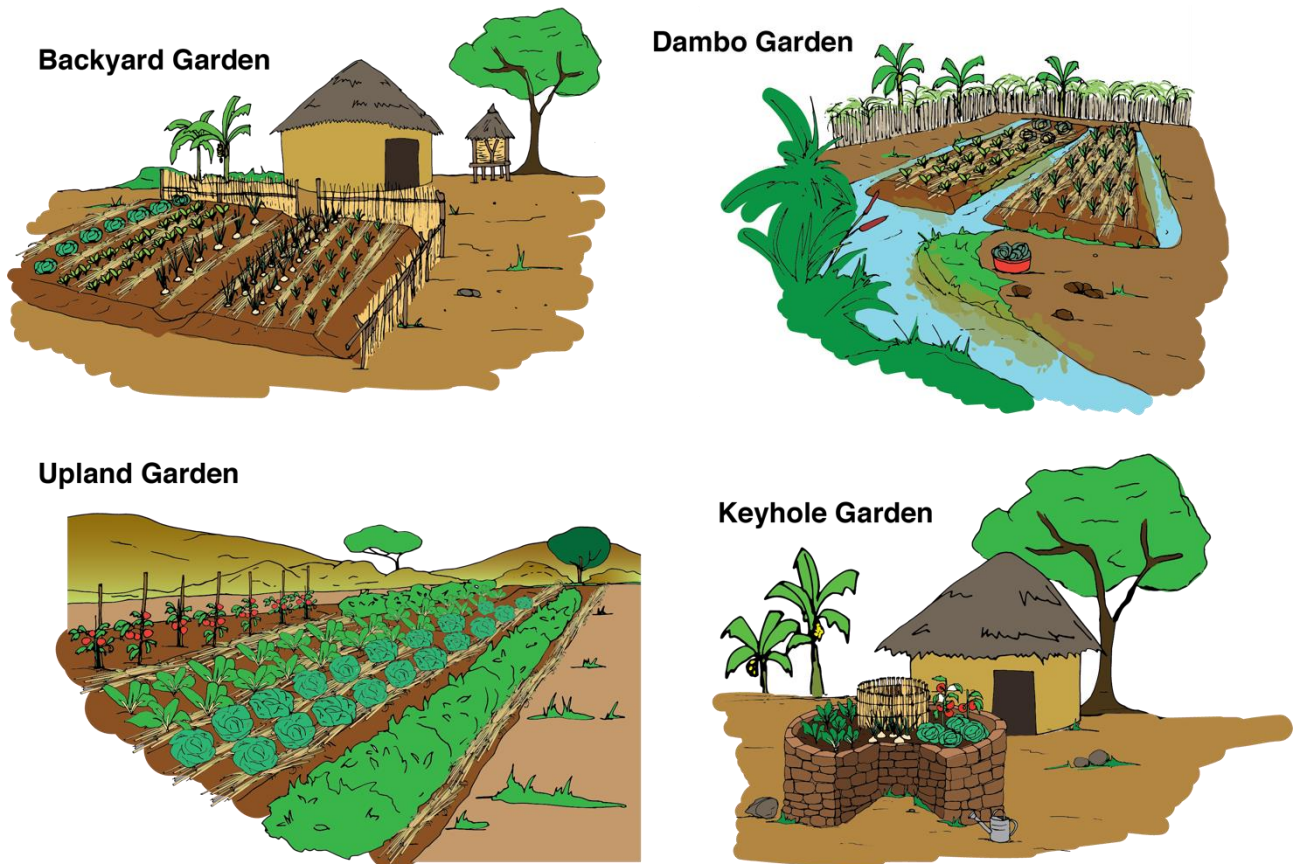
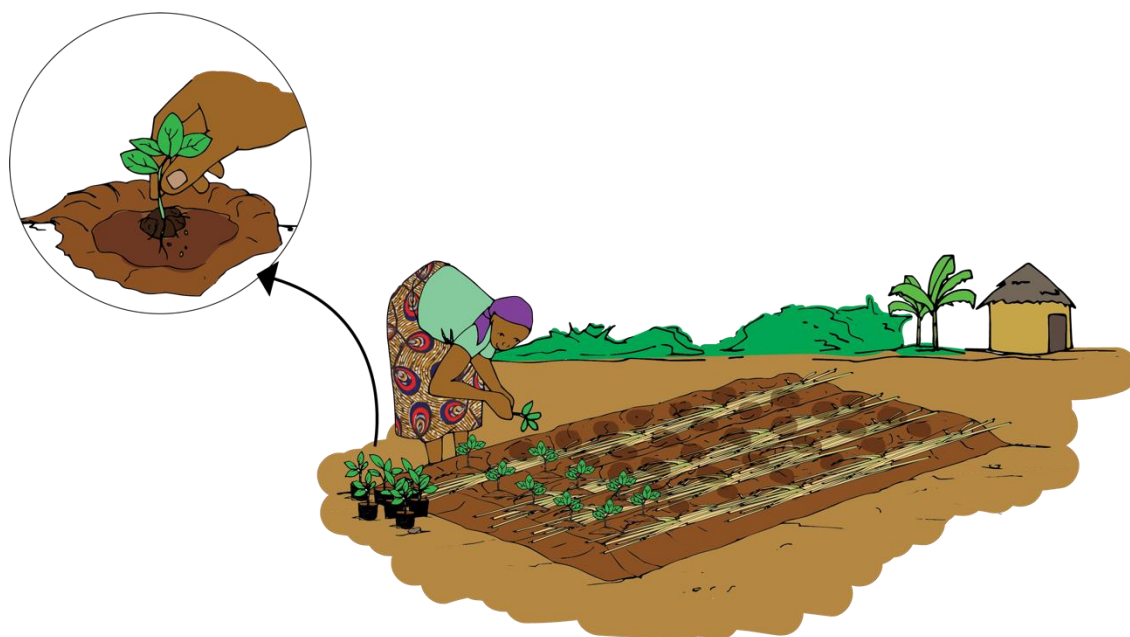


Figure 32: Types of vegetable garden

## TRANSPLANTING OF SEEDLINGS

- Seedlings are ready for transplanting when they are 4 to 6 weeks old and have developed three to four true leaves depending on the season.
- Transplanting should preferably be done in the morning during the cool months and late afternoon in hot months.
- Nursery should be adequately watered 3-4 hours before lifting the seedlings; seedlings are then lifted with some soil without disturbing the roots using a garden fork or shovel.
- Healthy and vigorous seedlings are selected and lifted from the nursery, weak seedlings remain in the nursery and transplanted when they are healthy and strong.
- After transplanting, seedlings should be in the main field at the spacing of 45cm x 30cm.
- In the main field, plant the seedlings at the recommended spacing depending on the type of vegetable crop.



**Figure 33: A farmer transplanting nursery plants in the field**

- **NOTE:** Transplanting Amaranthus is possible, but ideally plant the seeds directly in the main field for easier germination, in a sand mix and not more than 1 cm deep. Similarly, okra seed should be planted directly in the main field.



### STEP 3: PRACTICAL EXERCISE ON TRANSPLANTING INTO THE MAIN FIELD (90 MINUTES)

#### ***Instructions to the facilitator:***

- Identify the garden and field sites which to conduct the practical exercise on transplanting into the main field.
- Identify the participants with experience to demonstrate how to transplant and plant in the main field. Encourage them to clearly explain the steps during the demonstration.
- Allow every participant to take part in the demonstration process.



### STEP 4: SUMMARY (10 MINUTES)

#### ***Instruction to the facilitator:***

- Ask participants to share what they found more interesting about what they learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.
- Thank the participants for their participation and end session.

# LESSON 4: PRUNING AND STAKING IN TOMATO PRODUCTION



## LEARNING OBJECTIVES

1. To improve the skills of farmers in staking and pruning management practices for tomatoes



## TIME

2 hours 10 minutes



## TRAINING MATERIALS AND TOOLS

- Ropes
- Sticks or small poles.
- Sharp knife

## STEP 1. INTRODUCTION (10 MINUTES)

### *Instructions for the facilitator:*

- Recap the main points from the previous lesson.
  - What do you remember from the previous lesson?
  - Ask if there is anything needing clarification from the previous lesson.
- Methodology: Group work, Presentation and Practical exercise.
- Explain to the participants that today we shall focus on staking and pruning in tomato and eggplant production.



## STEP 2: GROUP WORK ON STAKING AND PRUNING OF TOMATOES AND EGGPLANTS (20 MINUTES)

### *Instruction for the facilitator:*

- Divide the participants into small groups of 5-7. Each group should be given the questions below for discussion:
  - What is staking and pruning?
  - When do you stake and prune tomatoes in the main fields?
  - Why do you stake and prune tomatoes in the main fields?

- How do you stake and prune tomatoes in the main fields?



### **STEP 3: GROUP PRESENTATIONS ON STAKING AND PRUNING OF TOMATOES AND PRODUCTION IN PLENARY (30 MINUTES)**

#### ***Instructions for the facilitator:***

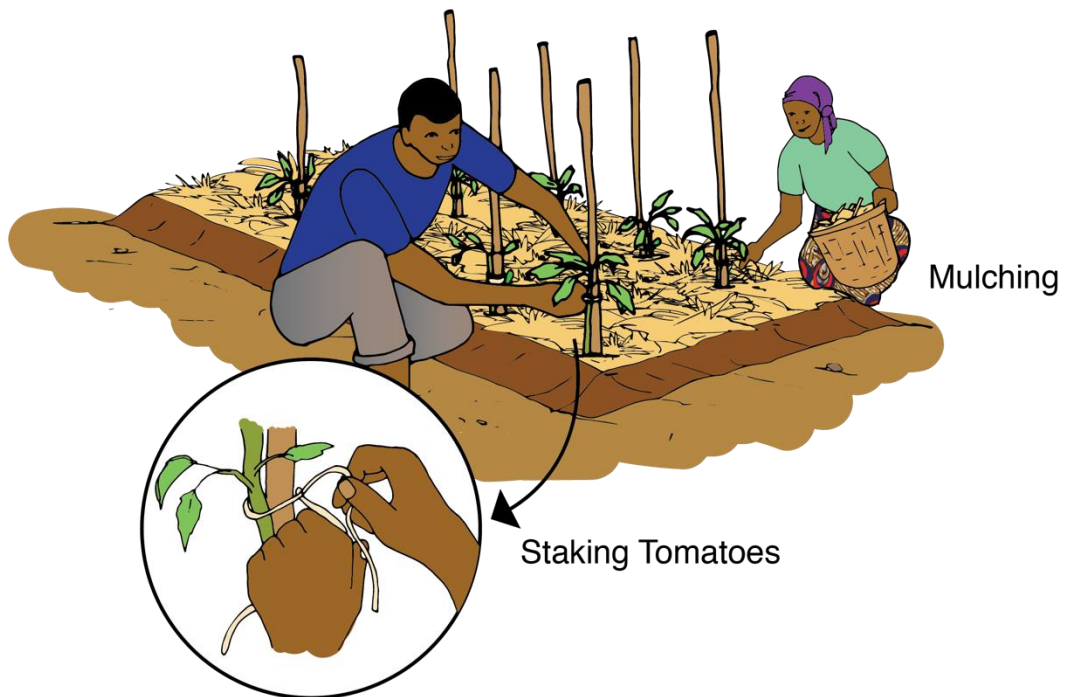
- Ask the group representatives to present the points of their discussion on staking and pruning in tomato production.
- Allow the participants to ask questions and make contributions to the presentations.
- Provide important information by giving a talk to the participants on staking and pruning in tomato production while considering what was shared in the plenary. After the talk, invite participants to ask questions for clarification.

## **STAKING**

- Staking and pruning are two common practices that can help tomatoes stay healthier and produce larger fruit. The system of staking you choose and how vigorously you prune your crop depends on the type of tomatoes you are growing.
- The process gives support to tomato plants and it's done at 3 to 4 weeks after transplanting.
- Staking is done using sticks and strings to give the plant upright growth. This increases the percentage of marketable fruits, enables easier harvesting and reduces injury to both plants and fruit at harvesting.



- Staking tomatoes provides support to help keep plants off the ground while assisting upright growth.



**Figure 34: Farmers staking tomatoes**

## PRUNING OF TOMATO PLANTS

- Pruning is carried out to remove excess suckers so as to maintain only one (1) or two (2) main stems at about 20cm above the ground.
- Pruning, which can be done using a knife or hands, helps to improve fruit size and reduces the incidence of disease.



**Figure 35: A farmer pruning tomato plants**



#### STEP 4: PRACTICAL EXERCISE ON STAKING AND PRUNING OF TOMATO PLANTS (60 MINUTES)

##### **Instructions to the facilitator:**

- Identify the garden site in which to conduct the practical exercise on staking and pruning in tomato plants.
- Identify the participants with experience to demonstrate how to stake and prune tomato plants. Encourage them to clearly explain the steps during the demonstration.
- Allow every participant to take part in the demonstration process.



#### STEP 5: SUMMARY (10 MINUTES)

##### **Instruction to the facilitator:**

- Ask participants to share what they found more interesting about what they learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.
- Thank the participants for their participation and end session.

## MODULE THREE: HARVESTING AND POST-HARVEST HANDLING OF VEGETABLES

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This module aims at equipping farmers with the adequate and necessary skills for harvesting and post-harvest handling of vegetables. The module discusses post-harvest handling including processing of vegetables, preservation of vegetables and vegetable seeds, storage of processed vegetables and seed extraction and storage.

These lessons include:

- Harvesting vegetables from the garden: leafy vegetables, tomato, eggplants, onion and okra.
- Processing, preservation and storage of leafy vegetables and onions.
- Processing, preservation and storage of tomato, eggplant and okra.
- Vegetable seed extraction, preservation and storage of tomato, Amaranthus, pumpkin and okra.
- **NOTE:** in case of unavailability of eggplants, impwa can be used.

# LESSON 1: HARVESTING OF VEGETABLES FROM THE GARDEN: LEAFY VEGETABLES, TOMATO, EGG PLANTS, ONION AND OKRA



## LEARNING OBJECTIVES

1. To know and understand the indicators for mature vegetables.
2. To know how to harvest mature vegetables from the garden.



## TIME

1 hours 20 minutes



## TRAINING MATERIALS AND TOOLS

- Knife
- Sack
- Ropes

## STEP 1. INTRODUCTION (10 MINUTES)

### *Instructions for the facilitator:*

- Recap the main points from the previous lesson.
  - What do you remember from the previous lesson?
  - Ask if there is anything needing clarification from the previous lesson.
- Methodology: Discussion in plenary and Practical exercise.
- Explain to the participants that today we shall focus on harvesting vegetables: leafy vegetables, tomato, eggplants, onion and okra.



## STEP 2: DISCUSSION AND PRACTICAL EXERCISE ON HARVESTING OF LEAFY VEGETABLES, ONION, TOMATO, EGGPLANT AND OKRA. (60 MINUTES)

### *Instruction to the facilitator:*

- Request the participants to go to the garden site for the practical exercise on harvesting vegetables.

- While in the garden, the facilitator should guide the discussions in plenary using the questions below:
  - When is the right time to harvest the leafy vegetables, onion, tomato, eggplant and okra?
  - What are the signs of mature vegetables?
  - During and after harvesting, what should we consider avoiding damage to and easy spoilage of the vegetables?
- After the discussion, the facilitator asks participants with experience in harvesting of the vegetables to demonstrate how to harvest. In case no participants have experience of how to harvest, the facilitator can demonstrate.
- Allow the participants to ask questions and make contributions during the practical exercise.
- Provide important information by giving a talk on harvesting vegetables while considering what was shared in the presentation.

## **HARVESTING OF VEGETABLES**

### **Leafy vegetables**

- Generally, vegetables are harvested as early as 4 to 8 weeks after transplanting depending on the level of management.
- They should not be left on the plants once they reach a good size otherwise, they will become tough.
- Harvesting of rape, chinese cabbage, mustard, spinach and pumpkin leaves is done by pulling with a twisting action. If leaves are removed with a knife, it should be done carefully and at an angle to avoid damaging other leaf stalks.
- The harvesting of the crop is over once upright growth stops.
- It is better to sow a few rows every few weeks to achieve succession rather than prolong the life of a single planting.
- The vegetables should be fertilized with manure/compost and manure tea after each harvest so that they can stay in the field much longer, at least for more than 45 days depending on the variety.
- The harvesting of pumpkin leaves begins as early as 4 to 6 weeks after sowing when leaves are still tender.
- The fruits are mature and can be picked individually using hands when the skin becomes hard and loses its shiny appearance.



**Figure 36: Farmers harvesting leafy vegetables in the main field.**



**Figure 37: Women harvesting pumpkin leaves and fruits.**

## **HARVESTING ONION**

- Bulbs mature 3 to 6 months after sowing, depending on the weather and the cultivar used. When the leaves begin to wither and die, lift the bulbs and leave them in the field under shade on the soil surface (spread out) to dry.
- Harvesting is done when 75% of the onion leaves have fallen off and is done by pulling the bulbs out of the soil after the leaves start turning yellow and the bulbs are firm.

## HARVESTING TOMATO

- Harvesting may start at 2 to 4 months after transplanting depending on management practices applied and the variety.
- **Pale green stage harvesting for tomatoes**, for distant markets harvest when the fruits are pale green and can stay for 10 - 14 days before sale.
- **Fully ripe stage harvesting for tomatoes**, for immediate sale or consumption, harvest when fruits are deep red, and this can be done by daily picking.
- **For eggplants**, harvesting is done when the fruits begin to turn deep purple.



Figure 38: Farmers harvesting tomato



Figure 39: Harvested tomatoes, packed in boxes

## HARVESTING OKRA

- Harvesting of okra should start when a few pods show signs of splitting. Harvesting individual pods by hand is necessary as the basal and apical pods mature at different times.
- For optimum quality, harvest okra that is 3 to 4 inches long. Harvest the pods while they are easy to break or cut from the stalk. For continued harvest, pick okra every day or two.
- Tender fruits must be picked regularly to avoid fibrous fruits and hard seeds. For the collection of seeds, okra should be left in the field until dry.

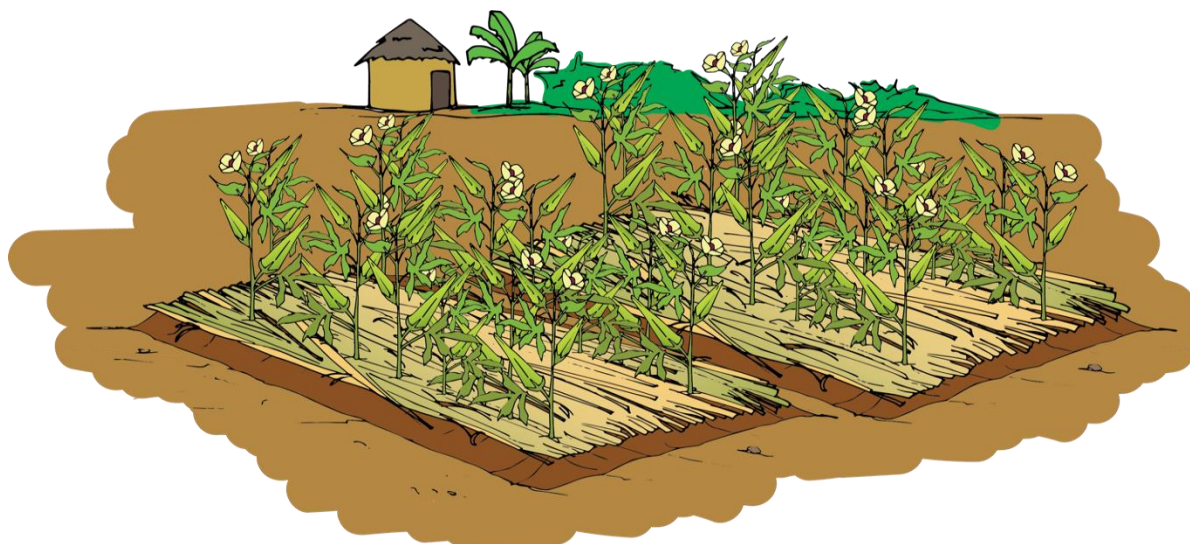


Figure 40: Field of Okra

## GENERAL CAUTIONS DURING HARVESTING

- Avoid tightly pressing or compacting the vegetables while packing them into bags for leafy vegetables or in boxes for tomatoes as this may damage the plants. Harvest in the cool hours of the day or at night.
- Avoid damage of vegetables as this may make the vegetables prone to post-harvest pests and diseases.



### STEP 3: SUMMARY (10 MINUTES)

#### **Instructions for the facilitator:**

- Ask participants to share the highlights of what they learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion content of the lesson.
- Thank the participants for their participation and end session.

# LESSON 2: PROCESSING, PRESERVATION AND STORAGE OF LEAFY VEGETABLES AND ONION



## LEARNING OBJECTIVES

1. To know how leafy vegetables and onion can be processed.
2. To know and understand how vegetables can be preserved and stored: Leafy vegetables and onion.



## TIME

3 hours 10 minutes

## TRAINING MATERIALS AND TOOLS



- Leafy vegetables and onion bulbs
- Pots
- Plates
- Braziers
- Water
- Knives
- Cooking sticks
- Salt
- Solar dryers
- Rack

## STEP 1. INTRODUCTION (10 MINUTES)

### *Instructions for the facilitator:*

- Recap the main points from the previous lesson.
  - What do you remember from the previous lesson?
  - Ask if there is anything needing clarification from the previous lesson.
- Methodology: Discussion in plenary and Practical exercise
- Explain to the participants that today we shall focus on processing, preservation and storage of leafy vegetables and onion.





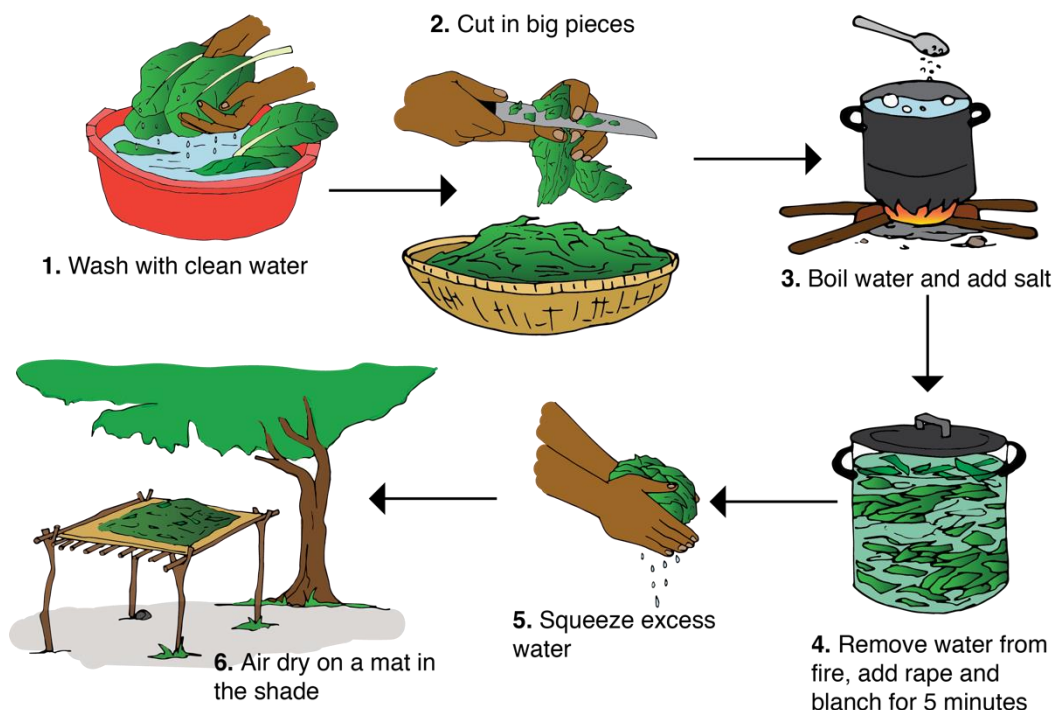
## STEP 2: DISCUSSION ON PROCESSING OF LEAFY VEGETABLES AND ONION IN PLENARY. (30 MINUTES)

### ***Instruction to the facilitator:***

- Show the participants the illustrations for processing leafy vegetables and onion on cards and ask them to explain what they see. Ask them the following questions to guide the discussion:
  - How do you process leafy vegetables and onion after harvesting?
  - Which methods of processing do you know?
  - For participants who don't process, what are reasons for not processing?
- Provide important information by giving a talk on processing of leafy vegetables and onion while considering what was shared in the plenary. After the talk, invite participants to ask questions for clarification.

## **PROCESSING OF LEAFY VEGETABLES**

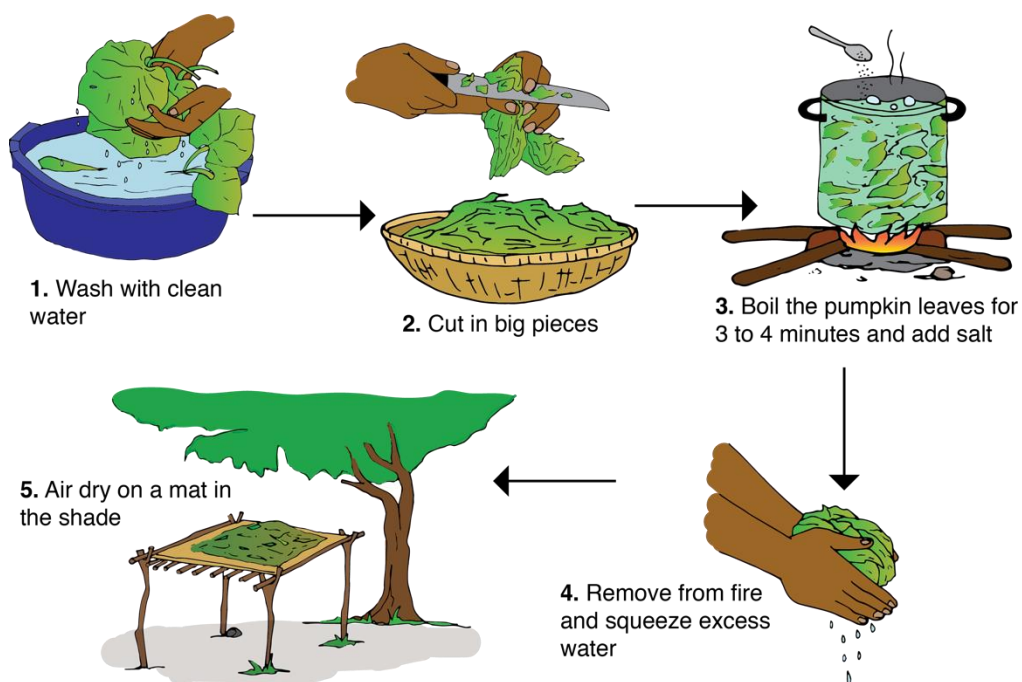
- This is the process of sorting, grading, cleaning, peeling, cooking and drying vegetables for immediate or future consumption or for the purpose of adding value for marketing.
- Processing transforms vegetables from perishable produce into stable foods with long shelf lives. The purpose of processing is to prevent or reduce decay of vegetable crops.
- Generally, the processing of leafy vegetables for preservation is done in the same way. Below is the procedure to follow when processing the leafy vegetables.
  - **Step 1:** Wash the leaves in a bucket with clean water.
  - **Step 2:** Cut the leaves into big pieces.
  - **Step 3:** Boil some water and add salt.
  - **Step 4:** Squeeze excess water and air dry on a raised rack in the shade or under a raised grass thatched roof and solar dryer to avoid loss of nutrients.
- **NOTE:** The vegetables are cut into bigger pieces to avoid losing the vitamins and while making the vegetables smaller after drying. Salt is added to preserve the vegetable ingredients as well as color.



**Figure 41: Processing of leafy vegetables**

## PROCESSING OF PUMPKIN LEAVES.

- **NOTE:** The steps or procedure for processing of pumpkin leaves is the same
- 



**Figure 42 Processing of pumpkin leaves**

## Processing pumpkin fruit into jam

- **Ingredients:** Lemon juice, salt, peeled pumpkin fruit and sugar
- **Method:**
  - **Step 1:** Cut into slices and peel.
  - **Step 2:** Boil until soft
  - **Step 3:** Mash the pulp using a pot or traditional mortar and measure using a cup  
Measure an equal amount of sugar to the amount of mash in a cup and mix.
  - **Step 4:** Bring to the boil stirring continuously until all sugar dissolves.
  - **Step 5:** Add 2 to 3 tablespoons of lemon juice (1 to 2 lemons)
  - **Step 6:** When set, the jam should slide slowly from the cooking stick.
  - **Step 7:** Pour into sterilized bottles and store in a cool place.

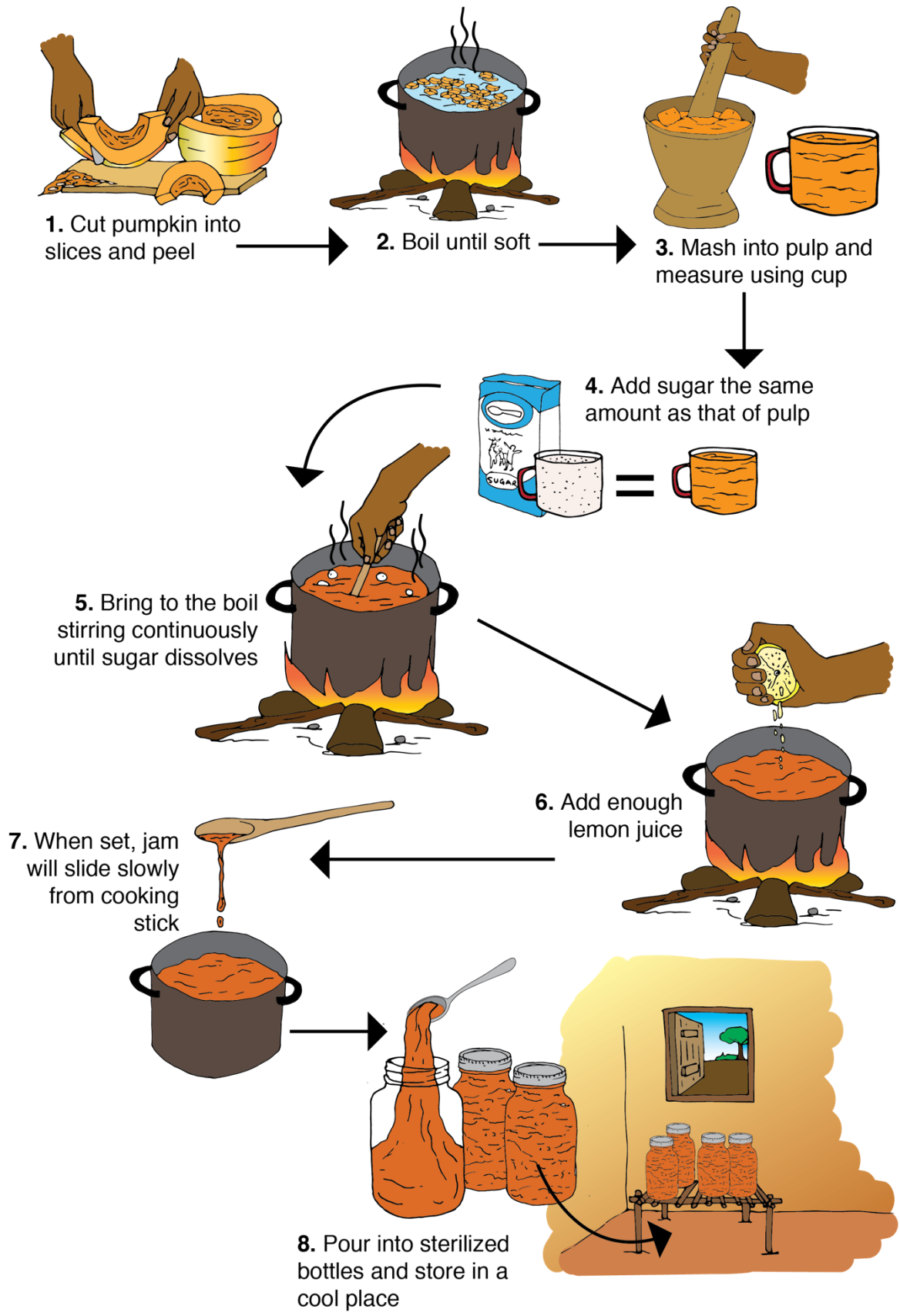


Figure 383: Processing of pumpkin fruit into jam

## PROCESSING OF ONION

- Onion can be processed and preserved by the following steps.
  - **Step 1:** Remove the dry outer layers.
  - **Step 2:** Cut the onion into big pieces.
  - **Step 3:** Put on a mat and air dry in the shade for 3 to 4 days.
  - **Step 4:** Store in a well-ventilated container, in a dry and cool place

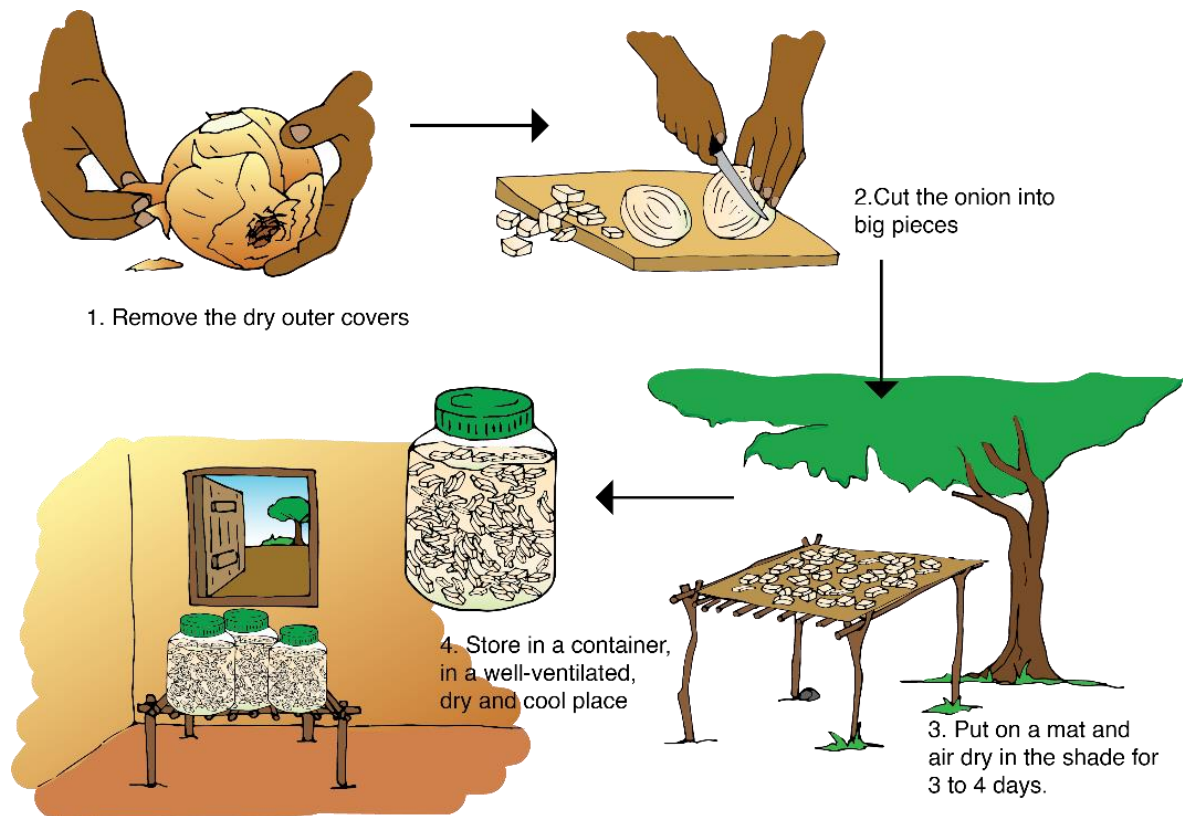


Figure 394: Processing of pumpkin fruit into jam



### STEP 3: DISCUSSION ON PRESERVATION AND STORAGE OF LEAFY VEGETABLES AND ONION IN PLENARY (30 MINUTES)

#### **Instruction to the facilitator:**

- Show the participants the illustrations for preservation of leafy vegetables on cards and ask them to explain what they see. Ask them the following questions to discuss further:
  - Which methods do you know about that are used for the preservation of leafy vegetables?
  - What are some of the preservation methods you use for leafy vegetables and why?
  - How do you store the preserved leafy vegetables and onion?

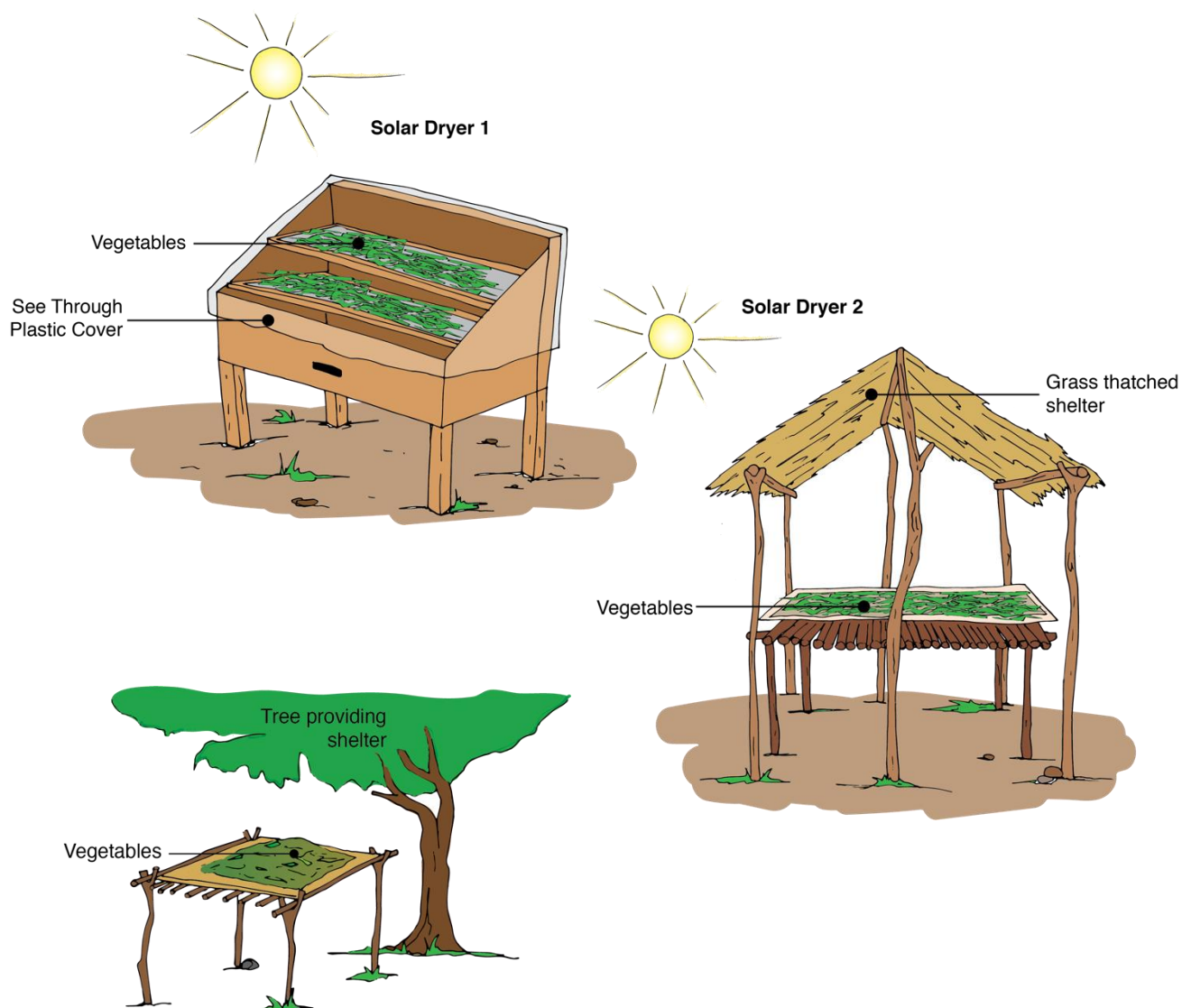


Figure 45: Drying of vegetables

## PRESERVATION OF LEAFY VEGETABLES

- Provide important information by giving a talk on processing of OFSP while considering what was shared in the plenary. After the talk, invite participants to ask questions for clarification.

## PRESERVATION OF LEAFY VEGETABLES AND ONION

- Preservation is the process of keeping vegetables from decay and spoilage by maintaining the quality until they are consumed or sold.

- After processing, vegetables can be preserved through drying them in the shade on a traditional improved rack and using a solar dryer. Drying in the shade and solar dryer is important for the following reasons:
  - There is less risk of contamination of vegetables because the products are protected from insects, dust, stones and other materials.
  - Drying using a solar dryer is faster hence more vegetables can be dried in a short time.
  - The vegetables taste nice and maintain a good color.
  - Nutrients are preserved.
- Onions can be preserved through drying in the shade after processing or the bulbs can be left drying in a cool dry place (shade).
- Onions store best if the tops can wither naturally, never bend them as this may favor the development of diseases.
- **NOTE:** Tomatoes, eggplants and okra are preserved in a similar way by drying in the shade and using solar dryers. Tomatoes can also be processed into powder.

## STORAGE OF DRIED VEGETABLES

- Fresh vegetables can be stored in a basket or sack for a few days. However, it is important to note that they easily spoil, hence it is recommended to process them and store them in sacks, traditional storage (Chikwati), plastic bags, plastic containers, e.g., buckets, jars for jam or for tomato sauce as well.
- The vegetables should be stored in a cool dry place.
- **NOTE:** This also applies to tomatoes, eggplant and okra.



### STEP 4: PRACTICAL EXERCISE ON PROCESSING AND PRESERVATION OF LEAFY VEGETABLES AND ONION (90 MINUTES)

#### ***Instructions to the facilitator:***

- Identify the household in which to do the practical exercise on processing and preservation of leafy vegetables and onion beforehand. Make sure all the required materials and equipment are available in advance.
- Identify the participants who can demonstrate the different types of processing and preservation beforehand.
- Then ask the identified participants to demonstrate the processing and preservation of leafy vegetables and onion. Encourage them to clearly explain the steps during the demonstration.
- Allow every participant to take part in the demonstration process.



## STEP 5: SUMMARY (10 MINUTES)

### ***Instruction to the facilitator:***

- Ask participants to share what they found more interesting about what they learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.
- Thank the participants for their participation and end session.



# LESSON 3: PROCESSING, PRESERVATION AND STORAGE OF TOMATO, EGGPLANT AND OKRA



## LEARNING OBJECTIVES

1. To improve the skills of farmers in the processing, preservation and storage of tomato, eggplant and okra



## TIME

2 hours 20 minutes

## TRAINING MATERIALS AND TOOLS



- Clean water
- Knife
- Pot
- Source of fire
- Mat/raised rack.
- Flip chart
- Markers

## STEP 1. INTRODUCTION (10 MINUTES)

### *Instructions for the facilitator:*

- Recap the main points from the previous lesson.
  - What do you remember from the previous lesson?
  - Ask if there is anything needing clarification from the previous lesson.
- Methodology: Discussion in plenary and Practical exercise
- Explain to the participants that today we shall focus on the processing, preservation and storage of tomato, eggplant and okra.



## STEP 2: DISCUSSION AND PRACTICAL EXERCISE ON PROCESSING AND PRESERVATION OF TOMATO, EGGPLANT AND OKRA (120 MINUTES)

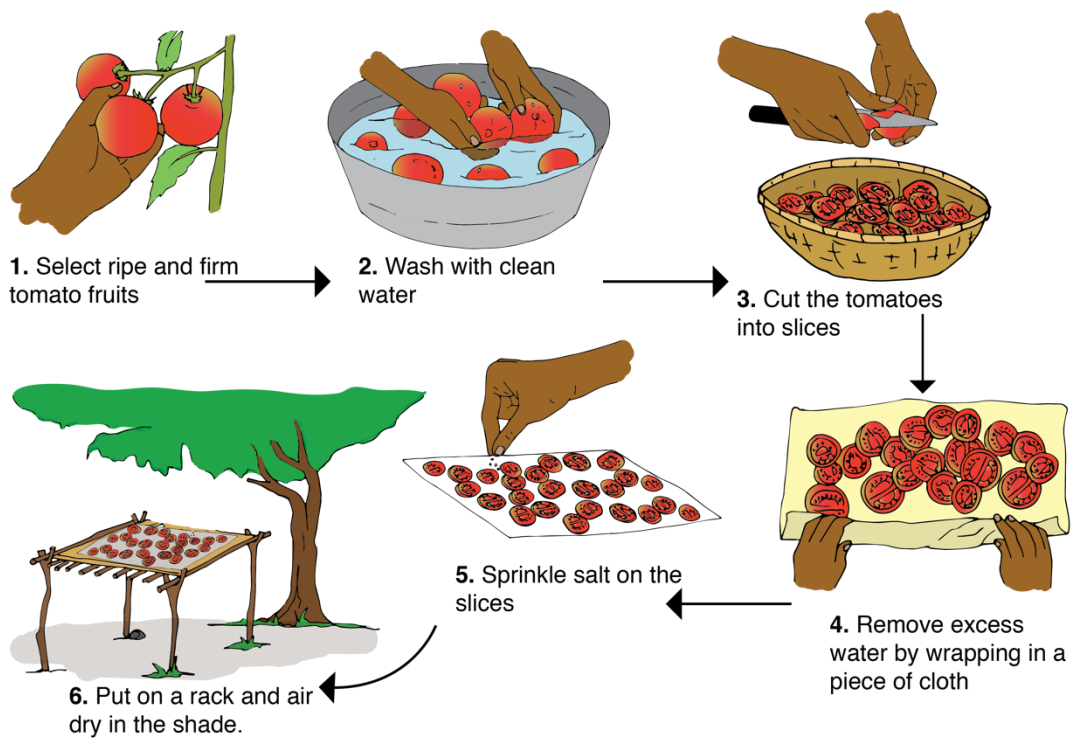
### *Instruction to the facilitator:*

- Request the participants to go to the site for the practical exercise on processing and preservation of tomato, eggplants and okra.
- While at the site, the facilitator should guide the discussions in plenary using the questions below:
  - Which methods do you know which are used for the preservation of tomato, eggplant and okra?
  - What are some of the preservation methods you use and why?
  - What do you use to store the preserved tomatoes, eggplant and okra?
- After the discussion, the facilitator asks participants with experience in processing and preservation and storage to demonstrate how to process, preserve and store. In case the participants don't have experience on how to process, preserve and store the facilitator can demonstrate.
- Allow the participants to ask questions and make contributions during the practical exercise.
- Provide important information by giving a talk on processing, preservation and storage while considering what was shared in the presentation.

## PROCESSING OF TOMATOES

- Below is the procedure to follow when processing the tomatoes:
  - **Step 1:** Select ripe and firm tomato fruits.
  - **Step 2:** Wash the tomato with clean water.
  - **Step 3:** Cut the tomato fruits into slices.
  - **Step 4:** Remove excess water by wrapping it in a piece of cloth.
  - **Step 5:** Sprinkle salt on the slices
  - **Step 6:** Put on a rack and air dry in the shade or in the solar dryer.

- Tomato can be processed into high-value products such as jam, juice, powder and tomato sauce which enables farmers to earn more income.

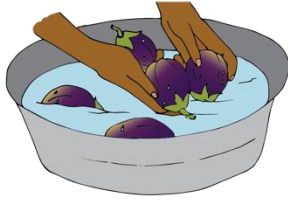


**Figure 46: Processing of tomato**

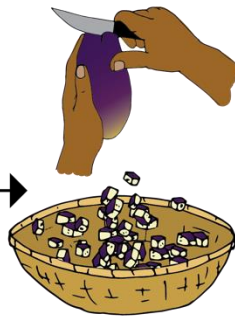
## PROCESSING OF EGGPLANTS

- Below is the procedure to follow when processing the eggplants:
  - **Step 1:** Wash the fruits and cut them into small pieces.
  - **Step 2:** Boil a bit of water and add a pinch of salt.
  - **Step 3:** Remove water from the fire and add eggplants, then blanch for 3 minutes.
  - **Step 4:** Dry the eggplant fruits on a mat in the shade or in the solar dryer.

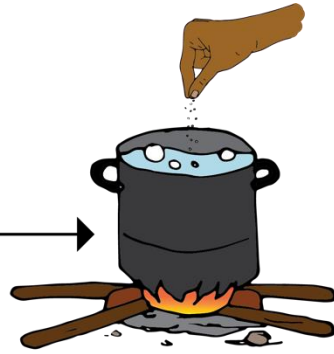
1. Wash with clean water



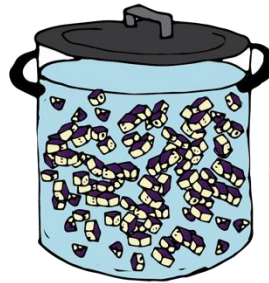
2. Cut into small pieces



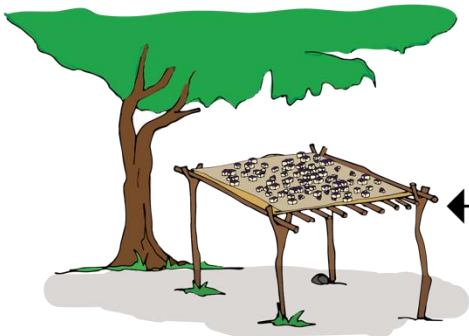
3. Boil water and add salt



4. Remove water from fire, add eggplants, then blanch for 3 minutes



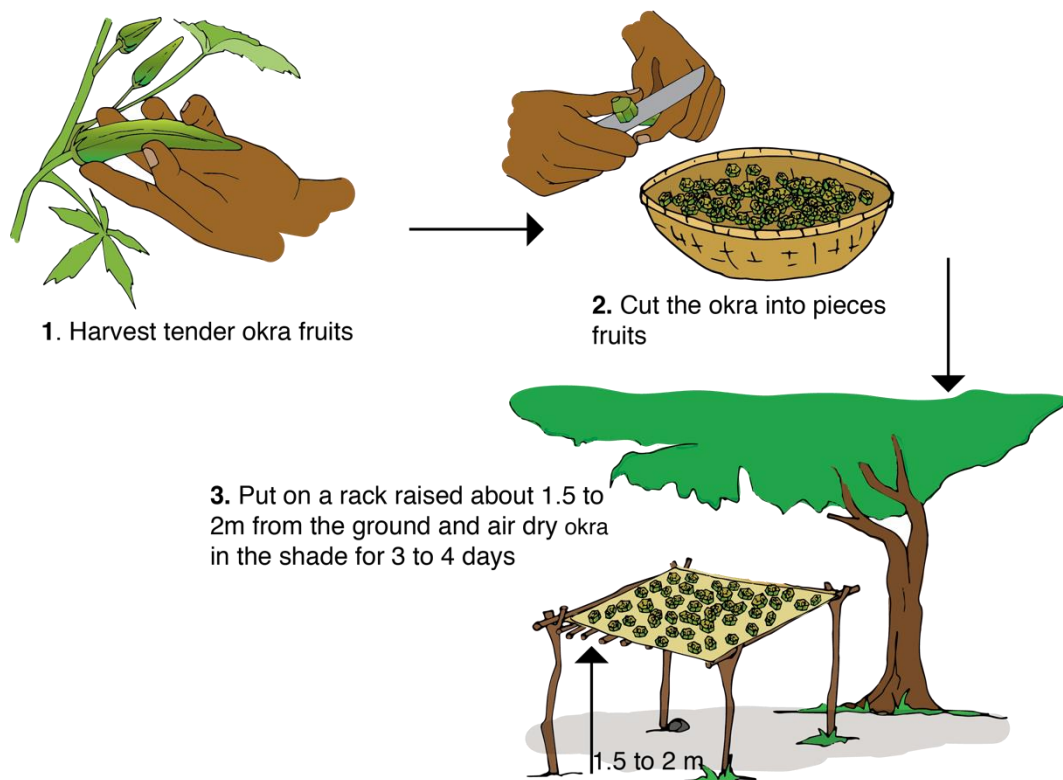
5. Dry the eggplant fruits on a rack in the shade with penetrating light



**Figure 47: Processing of eggplants**

## PROCESSING OF OKRA

- **Step 1:** Harvest tender okra fruits.
- **Step 2:** Cut the okra into pieces.
- **Step 3:** Put on a rack raised about 1.5m to 2m from the ground and air dry in the shade for 3 to 4 days.



**Figure 40: Processing of okra**



### STEP 3: SUMMARY (10 MINUTES)

**Instruction to the facilitator:**

- Ask participants to share what they found more interesting about what they learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.
- Thank the participants for their participation and end session.

# LESSON 4: VEGETABLE SEED EXTRACTION, PRESERVATION AND STORAGE FOR TOMATO, AMARANTHUS, PUMPKIN AND OKRA



## LEARNING OBJECTIVES

1. To enhance the knowledge and skills of farmers in extraction, preservation and storage of vegetable seeds.



## TIME

2 hours 20 minutes



## TRAINING MATERIALS AND TOOLS

- Knife
- Tray
- Mat

## STEP 1: INTRODUCTION (10 MINUTES)

### *Instructions for the facilitator*

- Recap the main points from the previous lesson.
  - What do you remember from the previous lesson?
  - Ask if there is anything needing clarification from the previous lesson.
- Methodology: Discussion and practical exercise
- Explain to the participants that today we shall focus on vegetable seed extraction, preservation and storage tomatoes, Amaranthus, pumpkins and okra.



## STEP 2: DISCUSSION AND PRACTICAL EXERCISE ON EXTRACTION, PRESERVATION AND STORAGE OF VEGETABLE SEEDS (120 MINUTES)

### *Instructions for the facilitator*

- Ask participants for their personal experience on extraction and preservation of tomato, eggplant, Amaranthus, pumpkins and okra seeds and record the answers on the flip chart:
  - When do you extract the seed from vegetables?

- How do you extract the seed from vegetables?
- How do you preserve the extracted seed?
- What precautions do you take for seed extraction?
- What type of materials do you use for seed storage?
- List down all the answers mentioned in plenary on the flip chart. Make additions to what participants mentioned.
- After the discussion, the facilitator asks participants with experience in seed extraction, preservation and storage to demonstrate how to extract, preserve and store seeds for tomato, eggplant, Amaranthus, pumpkins and okra. In case the participants don't have experience on how to extract, preserve and store, the facilitator can demonstrate.
- Allow the participants to ask questions and make contributions during the practical exercise.
- Provide important information by giving a talk on extraction and preservation of vegetable seeds, taking into consideration the experiences that participants shared.

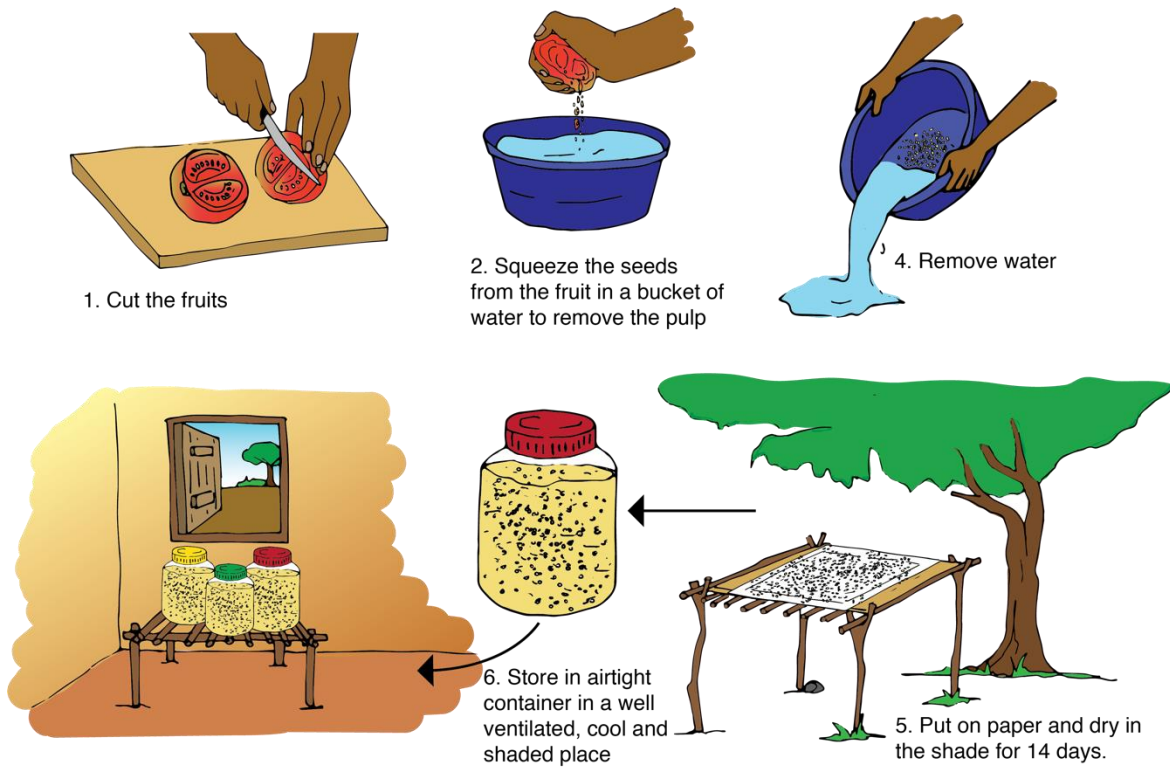
## SEED EXTRACTION

- Once the vegetables are mature enough, seeds can be extracted by different methods depending on the vegetable type.
- Seeds can be extracted manually, where fruits are cut into longitudinal bits, seeds are removed manually, remnants of the pulp are washed, and the seeds are dried. An example of vegetable for this method is pumpkin.
- Seeds like Amaranthus are left drying on the vegetable and removed manually. Okra can be plucked from the plants and left drying in the sun until the fruit opens to expose the seeds. They can then be collected.
- Seeds contain natural moisture, which at harvest time is often higher than the optimum required for the maximum potential of life and best germination. The amount of moisture in the seed is probably the most important factor influencing the longevity and germination capacity of the seed. It is important to dry the seeds for tomato, eggplants and pumpkin leaves after extraction.
- When the seeds are dry enough, put them in a plastic container for storage. Seeds like pumpkin can be stored mixed with ash to preserve them.

## EXTRACTION OF SEED FROM TOMATOES AND EGGPLANTS

- Below is the procedure to follow when extracting seed from tomatoes and eggplants:
  - **Step 1:** Cut the fruits.
  - **Step 2:** squeezed the seeds from the fruit in a bucket of water to remove the pulp.
  - **Step 3:** Put the seeds on paper and dry in the shade for 14 days.
  - **Step 4:** Store in an airtight container in a well-ventilated, cool and shaded place

- However, recycled seed should only be used once in each generation due to the fact that there could be low fruit productivity in the course of production.



**Figure 41: extraction of seeds from tomato**

## EXTRACTION OF SEED FROM AMARANTHUS

- Once the seeds mature, individual pinnacles should be cut and laid on the plastic sheet or sack. When it's completely dry, the seed is threshed, winnowed and collected.



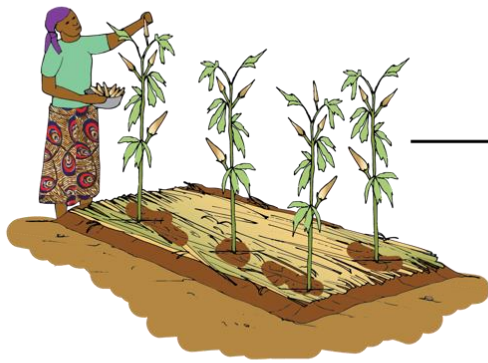
**Figure 42: Extraction of seed from Amaranthus**



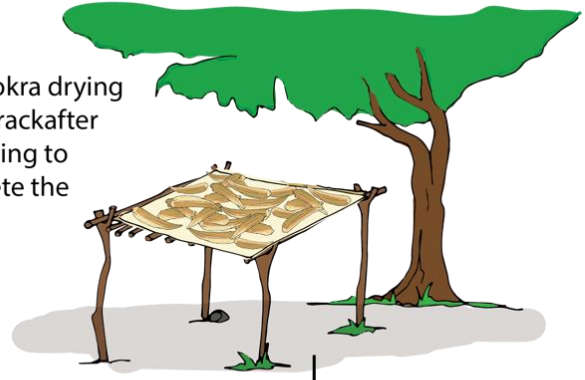
## EXTRACTION OF SEED FROM OKRA

- Harvesting should start when a few pods show signs of splitting. The harvested pods are then placed on a rack for drying. The pods are threshed on the sack and the seed is winnowed. Seed can further be dried and packed in a plastic container and put in a cold, dry place.

### 1. Harvest mature dry okra



2. Dry okra drying on the rack after harvesting to complete the drying.



4. Stored in a cool and dry place and ready for planting



3. Dry okra are opened, and seeds are collected

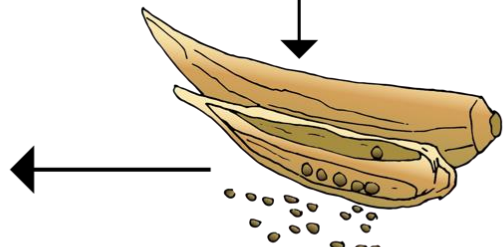


Figure 43: Extraction of seeds from okra

## EXTRACTION OF SEED FROM PUMPKINS

- Below is the procedure to follow when extracting seed from pumpkin
  - Cut the fruits from the top with a knife and remove the pulp from the seeds by hand
  - Collect the seeds by hand
  - Air dry the seeds in shade on a rack
  - Store the well-dried seeds in an airtight container in a cool place

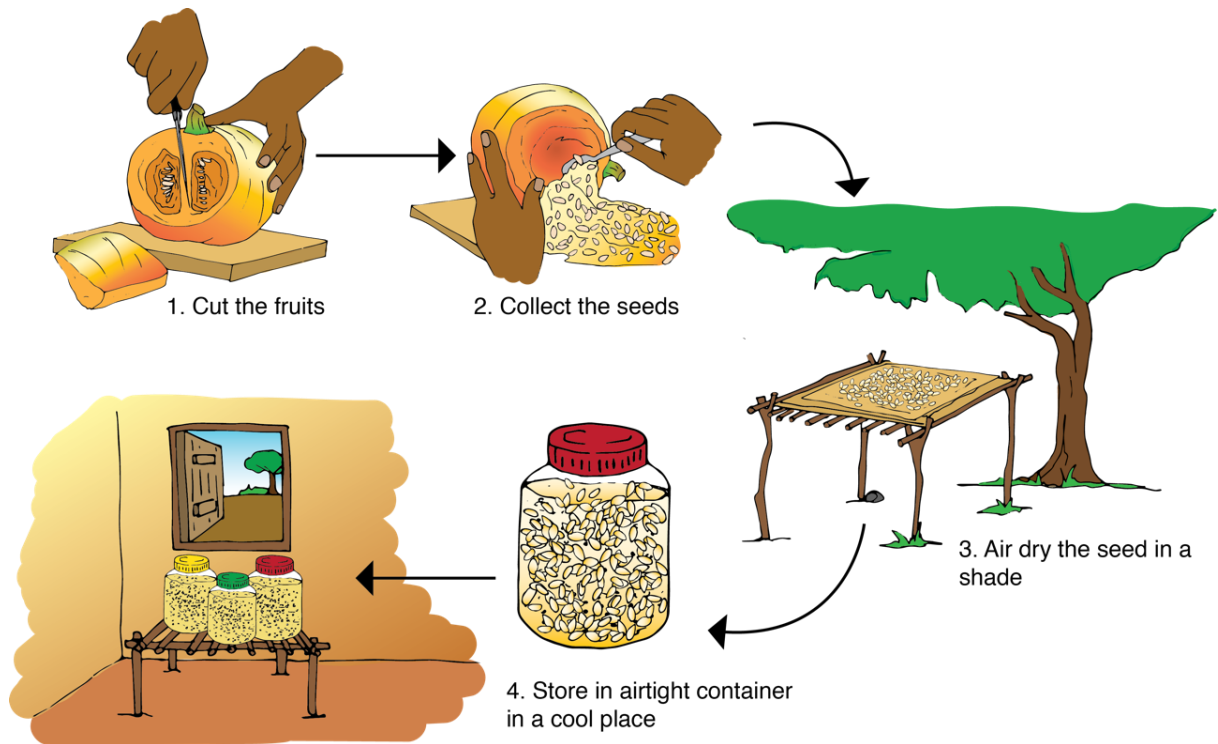


Figure 44: Extraction of seeds from pumpkin



### STEP 3: SUMMARY (10 MINUTES)

#### **Instruction to the facilitator:**

- Ask participants to share what they found more interesting about what they learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.
- Thank the participants for their participation and end session.

## LITERATURE CONSULTED

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