POST HARVEST MANAGEMENT PRACTICES MANUAL FOR TRAINERS

HARVESTING, PROCESSING, PRESERVATION AND STORAGE

Leafy Vegetables, Legumes, Orange Fleshed Sweet Potatoes and Orange Maize

FANSER
Food and Nutrition Security, Enhanced Resilience

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Foreword

This Post-Harvest-Management- Practices Manual for trainers was produced under the Food and Nutrition Security, Enhanced Resilience Project (FANSER) in Zambia. The FANSER Project has been commissioned by the German Federal Ministry of Economic Cooperation and Development (BMZ) as part of the Special Initiative “Transformation of Agricultural and Food Systems” and is implemented by GIZ. 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.

Adequate Post-Harvest-Management-Practices (PHMP) are important in addressing food insecurity and malnutrition and have gained global attention in research and development over the past decade. Under the FANSER Project, Post-Harvest-Management is a key activity being used to improve food and nutrition security. Adequate and innovative processing, preservation and storage techniques are key to ensure that nutritious foods are available all year-round at household levels. The content of this training manual focuses on the following four key elements of PHMP: harvesting, processing, preservation and storage of crops which are rich in important micro- and macronutrients such as green leafy vegetables, legumes, Orange Fleshed Sweet Potatoes and Orange Maize.

With this manual, we want to encourage agricultural extension staff and trainers, who work with smallholder farming communities, women’s groups, etc. to continue the promotion of adequate Post-Harvest-Management Practices for increased availability and consumption of nutritious and safe foods and thereby, to support Zambia`s effort in the fight against malnutrition and hunger.

Therefore, this manual has been developed to enhance information delivery and communication of good and innovative post-harvest management practices for agricultural extension officers.

Dr Heike Hoeffler

Food and Nutrition Security Coordinator GIZ, Zambia.

Acknowledgment

This Post-harvest Management Practices user manual is the result of the efforts of the stakeholders involved in nutrition sensitive agriculture to improve the Food and nutrition status of women and children during the 1000 most critical days. The FANSER project would therefore like to thank the Ministry of Agriculture (MoA) and other stakeholders for the technical support provided during the development of this manual. Additionally, we would like to thank the German Federal Ministry for Economic Cooperation (BMZ) for funding the Food and Nutrition Security Enhanced Resilience (FANSER) project implemented by GIZ in collaboration with the Catholic Relief Services which supported the entire process in the development of this user manual.

Special thanks also go to the World Food Programme (WFP) whose training manual entitled Household food processing, preservation, storage, and utilization was extensively consulted among other materials during the development of this training manual.

We hope the information in this booklet will help to improve the health and nutrition status of women and children in the 1000 most critical days in Zambia. The booklet can be adapted for use in various parts of Zambia to sustainably improve household food and nutrition security.

Development of this training manual

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How to Use This Training Guide

This training manual is intended to be a guide for trainers that deliver learning events in post-harvest management practices to farming households and communities. It uses illustrations, group activities, and examples which adult learners can easily relate to and understand. Therefore, facilitators are encouraged to consider the following in this manual: the teaching instructions, and the allocated time slots as a guide. This guide is complemented by training cards with illustrations which shall be used during the trainings to support the delivery of the content.
The manual therefore uses different methodologies for delivering the training content to the target groups to effectively facilitate adult learning.

Facilitation Guide

	**LEARNING OBJECTIVES:** The facilitator should clearly explain the objectives of the training to the participants.
	**DURATION:** The facilitator should mention how long the lesson will take to the participants. Most of the Lessons have been given one (1) hour duration
	**TRAINING MATERIALS AND TOOLS:** All the training materials and tools should be made available in advance to effectively deliver the training.
	**DISCUSSION:** The facilitator should initiate and guide discussions by asking questions and encourage participants to share their knowledge, opinions, views, or experiences. Participants should continue the discussions among themselves. Participants should be encouraged to ask and answer questions.
	**GROUP WORK:** The facilitator should guide participants to form groups for discussions and exercises. Activities have been provided to guide the discussions. However, Facilitators are allowed to change or modify the activities depending on the level of participants and the prevailing situation;
	**PRESENTATION:** The facilitator should ask the groups to make presentations after group discussions or exercises.
	**PRACTICAL WORK/DEMONSTRATION:** The facilitator should lead and guide participants to demonstrate on the lessons covered.
	**LESSON SUMMARY:** Participants should share the key points learnt and the facilitator should thereafter summarize the lesson

INTRODUCTORY LESSON: MEANING AND IMPORTANCE OF POST HARVEST MANAGEMENT PRACTICES (PHMPs).

	LEARNING OBJECTIVES 1. To understand what post- harvest management means 2. To understand the importance of post-harvest management Practices. 3. To know the effects of poor post-harvest practices
	**TIME** 50 Minutes
	**TRAINING MATERIALS** • Flip chart • Markers

STEP 1: INTRODUCTION (10 MINUTES)

Instructions for the facilitator

- Explain to the participants that today we shall focus on the meaning and importance of post-harvest management practices.
- **Methodology:** Discussion in plenary
- Encourage participants to share their experiences and expertise freely.

STEP 2: DISCUSSIONS ON THE MEANING AND IMPORTANCE OF POST-HARVEST MANAGEMENT IN PLENARY (30 MINUTES)

Instructions for the facilitator*:*

- Ask participants the following questions regarding their personal experience on the meaning and importance of Post Harvest Management.
    - What is the meaning of Post Harvest Management?
    - What is the importance of Post Harvest Management important?
    - What are the negative impacts of poor Post Harvest Management?
- Provide important information by giving a talk to the participants on the meaning and importance of Post Harvest Management considering what was shared in the plenary. After the talk, invite participants to ask questions for clarifications.

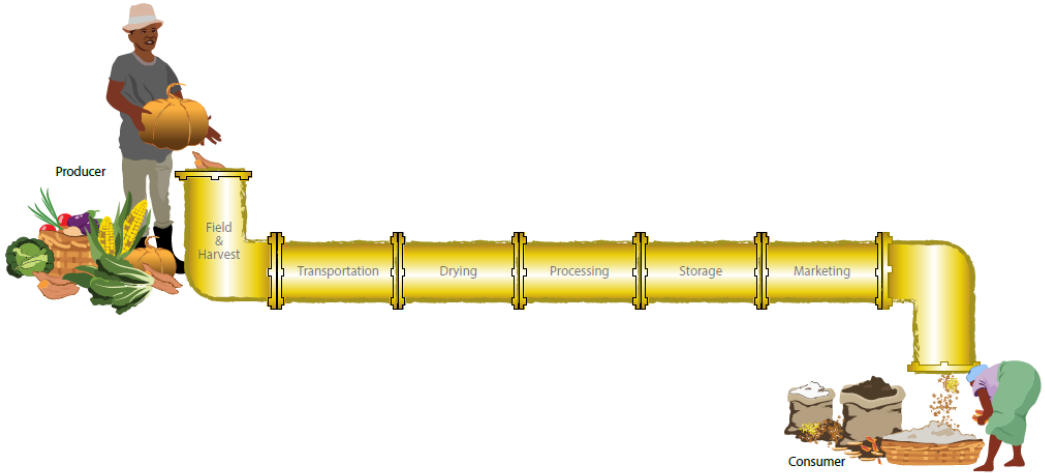

Figure 1 - Food Pipeline

Meaning of post-harvest management

- A process of handling, processing, storage, and transporting agricultural commodities after harvest.
- It focuses on preserving quality (including nutritional quality of the food), quantity, and the safety of the food.
- Also ensures that moisture, contaminants, insects, and processing do not affect the quality and safety of the food.
    - Quality parameters: appearance, texture, flavour, taste, nutritional value, etc.
    - Food safety parameters: chemical, physical, and microbial hazards.

Importance of post-harvest management

- Post-harvest treatments are essential for increasing the shelf life and availability of food.
- Post-harvest management helps in reducing food loss and waste from production to the consumer and throughout the supply chain.
- It helps in ensuring all year-round availability of good quality food.
- It increases income as producers can sell excess produce when prices get better.
- Post-harvest techniques add value to products and improve nutrition.

Negative impacts of poor post-harvest management practices

- Can lead to loss in the nutritional value of food leading to malnutrition.
- Contamination of products such as maize and groundnuts with aflatoxins can cause illnesses to consumers.
- Low quality of produce and therefore fetching low prices on the market
- Loss in portion of yield, therefore leading to low incomes from sales.
- Contamination of produce/food leading to diseases and ill-health.

STEP 3: SUMMARY (10 MINUTES)

Instructions for the facilitator

- Allow the participants to ask questions for any clarification.
- Ask participants to share the highlight of what they have learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion content of the lesson.

MODULE ONE: POST HARVEST MANAGEMENT PRACTICES OF LEAFY VEGETABLES.

This module aims to equip readers and farmers with necessary skills and knowledge on post-harvest management practices of vegetables. Fresh vegetables are a key source of essential vitamins and minerals, such as vitamin A, vitamin C and potassium, needed for human healthy. These vegetables are, however, perishable and require coordination by farmers, storage operators, processors, and retailers to maintain quality and reduce food loss and waste. The following vegetables will be considered; Leafy vegetables; (Swisschard, amaranthus, rape, mustard (Mpilu), Chinese cabbage, Pumpkin leaves among others).

This module has a total of three (3) lessons.

- Harvesting and handling
- Processing and preservation
- Storage

LESSON 1: HARVESTING AND HANDLING OF LEAFY VEGETABLES

	**LEARNING OBJECTIVES** 1. To understand the indicators for mature leafy vegetables. 2. To know how to handle harvested leafy vegetables.
	**TIME** 50 Minutes
	**TRAINING MATERIALS** • Flip charts • Markers • Baskets/sacks • Leaf vegetables

STEP 1: INTRODUCTION - 10 MINUTES

Instructions for the facilitator

- Recap on 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 participants that today we shall focus on harvesting and handling leafy vegetables.

STEP 2: DISCUSSION ON HARVESTING AND HANDLING AND PRACTICAL EXERCISE ON HARVESTING OF LEAFY VEGETABLES (30 MINUTES)

Instructions for 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:
  - What are the signs of mature vegetables?
  - What is the right time of the day to harvest the leafy vegetables?
  - How can you avoid damage and easy spoilage of the vegetables during and after harvest respectively?

- What are some of the precautions that should be considered during handling?

- After the discussion, the facilitator asks participants with experience in harvesting leafy vegetables to demonstrate how to harvest. In case no participants have experience on 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 of leafy vegetables while considering what was shared in plenary.

Figure 2 - Farmers harvesting vegetables.

Harvesting of 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 are mature, otherwise they will become hard.
- Harvesting of rape, Chinese cabbage, mustard spinach, 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 growth stops.
- It is better to plant a few seeds for nursery every few weeks for continuous vegetable production.

- The vegetables should be fertilized with organic fertilizer (manure, compost, manure tea) after each harvest to maintain the growth, at least for more than 45 days depending on the variety.

Figure 3 - Good Quality harvested Vegetables.

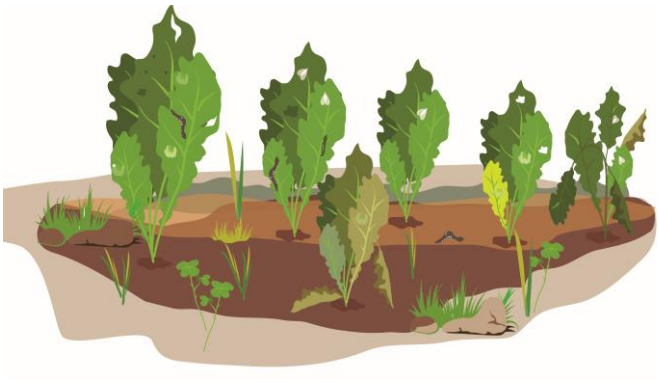

Figure 4 - Poor quality vegetables.

Handling of leafy vegetables after harvest

- Vegetables at house-hold level are mainly handled manually.
- All vegetables should be handled gently to minimize bruising and breaking of the leaves or skin.
- Injuries on vegetables increase microbial attack and physiological losses, therefore, avoid injuries to the crop while handling.
- The leaves or skin of vegetables are an effective barrier to most of the opportunistic bacteria and fungi that cause rotting of the tissues.
- Breaking of the leaves or skin also stimulates physiological deterioration and dehydration.
- Reducing the number of times the commodity is handled reduces the extent of mechanical damage.
- Vegetables should be gently put in containers such as baskets and sacks to avoid injuries.

STEP 3: SUMMARY (10 MINUTES)

Instructions for the facilitator:

- Allow the participants to ask questions for any clarification.
- Ask participants to share the highlight of what they have learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion content of the lesson.

LESSON 2: PROCESSING AND PRESERVATION OF LEAFY VEGETABLES.

	**LEARNING OBJECTIVES** 1. To know how leafy vegetables can be processed. 2. To know and understand how leafy vegetables can be preserved.
	**TIME** 1 hour 50 Minutes
	**TRAINING MATERIALS** • Flip charts • Markers • 10 Kg of vegetables • 50 liters of water • Brazier • Charcoal • 1kg Salt • 2 Big pots • 2 big trays • 2 dishes • Knife • Spoons • Cooking stick • 10kg clean empty sack

STEP 1: INTRODUCTION (10 MINUTES)

Instructions for the facilitator:

- Recap on from the previous lesson.
    - What do you remember from the previous lesson?
    - Ask if there is anything needing clarification from the previous lesson.
- Explain that today we shall focus on processing and preservation of leafy vegetables.
- **Methodology:** Discussion and Practical exercise
- Encourage participants to share their experiences and expertise freely.

STEP 2: DISCUSSION ON PROCESSING AND PRESERVATION IN PLENARY. (30 MINUTES)

Instructions for the facilitator:

- Show the participants the illustrations for processing of leafy vegetables 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 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 and preservation of leafy vegetables while considering what was shared in the plenary. After the talk, invite participants to ask questions for clarification.

Processing and preservation of leafy vegetables.

- Vegetables comprise a broad group of plants consumed as food.
- Perishable when fresh but can be processed using several methods such as blanching, steaming and drying.
- They are excellent sources of nutrients such as minerals, vitamins, and dietary fibre.
- The availability of fresh vegetables differs greatly in different regions, because of the varied growing and harvesting seasons of different vegetables at different locations.
- Due to the perishable nature of the fresh produce, increased shelf-life lead to availability of vegetables through processing and preservation.
- Processing can transform vegetables from perishable produce into stable foods with long shelf lives.
- The purpose of processing is to prevent or reduce vegetables from spoiling quickly.
- Vegetable processing techniques include **blanching, dehydrating (drying), canning, freezing, fermenting, and pickling.**
- Processed products give consumers access to a wider choice of products and a wider range of vitamins and minerals.

Factors that affect nutritional quality.

- **Over processing**: will expose nutrients to leaking, heat, and other factors. Reduce the fibre content.
- **Over cooking:** will denature some nutrients (Cooking vegetables until they are brown – lose their green colour).
- **Leaching:** when soaked in water; nutrient will leach into the water and drained away (Cutting and washing the vegetables – then draining away the water).

- **Light:** light will breakdown down nutrients especially vitamins (Leaving vegetables in direct sunlight breaks down the nutrients).
- **Exposure to oxygen (air):** vitamins will react with oxygen and lose their value (dried vegetables – if they remain exposes, they will lose taste and flavour.)

STEP 3: PRACTICAL EXERCISE ON PROCESSING AND PRESERVATION OF VEGETABLES (60 MINUTES)

Instructions for the facilitator.

- Identify the household where to conduct a practical exercise on processing and preservation of vegetables beforehand.
- Make sure that all the required materials and equipment are available in advance.
- Identify the participants who can demonstrate the blanching, steaming and drying beforehand.
- Then ask the identified participants to demonstrate the processing and preservation of vegetables.
- Encourage them to clearly explain the steps during the demonstration.
- Provide important information by giving a talk on processing of leafy vegetables. After the practical, invite participants to ask questions for clarification.

Blanching

- Blanching vegetables before drying them is critical for quality, but not safety.
- Blanching is scalding vegetables in boiling water or steam for a short time.
- It is typically followed by quick, thorough cooling in very cold or ice water.
- Blanching stops enzyme actions which otherwise cause loss of flavour, colour, and texture.
- Blanching removes some surface dirt and microorganisms, brightens colour, and helps slow vitamin losses.
- It softens vegetables and makes them easier to pack.
- Under-blanching stimulates enzyme activity and thus is worse than no blanching.
- Over-blanching leads to partial cooking and causes loss of flavour, colour, vitamins, and minerals.

Drying

- Choose the vegetables you want to dry.
- Wash and cut the vegetables.
- Pre-treat vegetables (to avoid browning or spoilage)
    - Lemon juice
    - Blanching

- Salting

- Drying types include:
  1. Sun drying – under the shade using a raised rack.
  2. Solar drying.

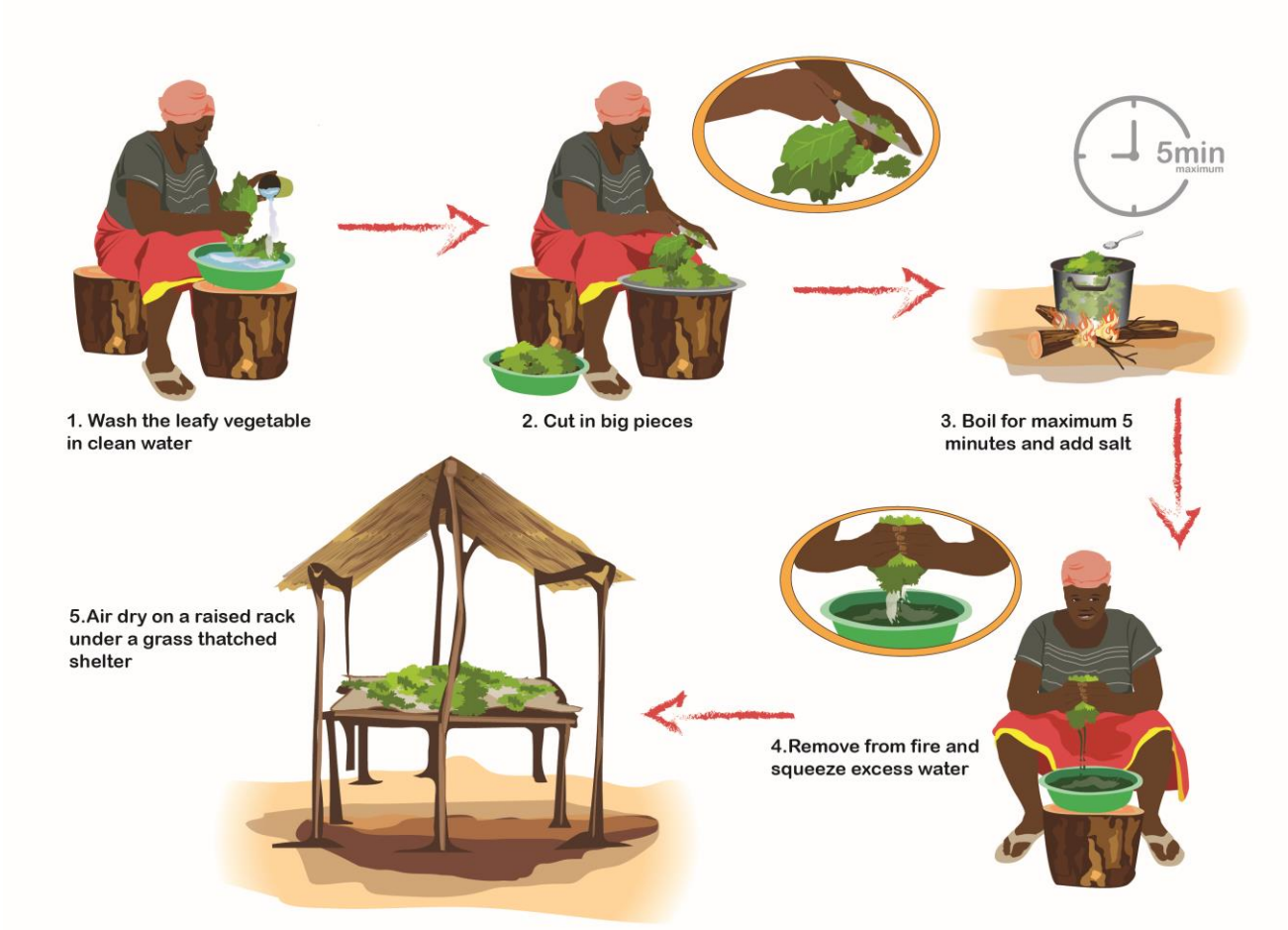

Figure 5 - Blanching and drying leafy vegetables.

Figure 6 – Drying (Air drying - drying under the shade and Solar drying)

STEP 4: SUMMARY (10 MINUTES)

Instructions for the facilitator

- Allow the participants to ask questions for any clarification.
- Ask participants to share what they found most interesting, about what they have learnt during the lesson and how they will use it.
- Consolidates and summarizes the main discussion points.

LESSON 3: STORAGE OF VEGETABLES

	**LEARNING OBJECTIVES** 1. To know and understand how leafy vegetables can be stored.
	**TIME** 1 hour
	**TRAINING MATERIALS** • Flip charts • Markers • Buckets • Plastic bags • Plastic bottles • Chikwati (traditional storage made from leaves)

STEP 1: INTRODUCTION (10 MINUTES)

Instructions for the facilitator

- Recap on 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.
- Explain that we shall focus on storage of both dried and fresh vegetables.
- **Methodology:** Group Discussions
- Encourage participants to share their experiences and expertise freely.

STEP 2: DISCUSSION IN GROUPS ON STORAGE OF VEGETABLES (20 MINUTES)

Instructions for the facilitator

- Divide the participants into small groups of 5 – 7 and ask them to discuss the questions below on storage.
  - What types of storage do you know which are available locally?
  - What are some of the good practices that should be observed before and during storage?
  - What are some of the bad practices that should be avoided before and during storage?

- After the discussion, ask the group representatives to present the main points of their discussion and make notes of their points on the flip chart or paper.

STEP 3. GROUP PRESENTATIONS FROM THE DISCUSSIONS IN PLENARY (20 MINUTES)

Instructions for the facilitator

- Ask the group representatives to present the main points 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 to the participants on storage considering what was shared in the presentations.

Storage

- Only crops with high initial quality can be stored successfully; It is therefore essential to ensure that only crops of the highest quality (mature, undamaged) are stored.
- Shelf life can be extended by maintaining a commodity at its optimal temperature, relative,
  humidity, and environmental conditions.
- Ensure products are protected from pest infestation such as rats, weevils and moulds.
- **Good storage practices** should be observed at all levels to ensure that the quality of the vegetables is maintained.
  - Keep them in a cool dry place.
  - Ensuring pests are controlled from infesting. Do not allow domestic animals near storage.
  - Avoid storing with other unrelated products.
  - Ensuring that the place of storage is clean.
  - Ensuring that they are not in direct contact with the floor and wall.
  - Keeping away all chemicals and substances that can cause contamination.
- Cross-contamination from other foods, non-foods and surfaces can also occur during storage and therefore, care should be taken.

Figure 7 - Various methods of storage for dried vegetables.

STEP 4: SUMMARY (10 MINUTES)

Instructions for the facilitator

- Allow the participants to ask questions for any clarification.
- 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.

MODULE TWO: POST HARVEST MANAGEMENT PRACTICES OF LEGUMES

This module aims at equipping farmers with the adequate and necessary skills for harvesting and post-harvest handling of legumes. The module discusses post-harvest handling including processing, preservation and storage of legumes.

These lessons include:

- Harvesting of legumes (cowpeas, beans, groundnuts, soya beans and Bambara nuts, pigeon peas).
- Processing and preservation of legumes (cowpeas, beans, groundnuts, soya beans and Bambara nuts)
- Storage of legumes (cowpeas, beans, groundnuts, soya beans and Bambara nuts)

LESSON 1: HARVESTING AND HANDLING OF LEGUMES.

	**LEARNING OBJECTIVES** 1. To understand the indicators for mature legumes. 2. To know how to handle harvested legumes.
	**TIME** 1 hour 30 Minutes
	**TRAINING MATERIALS** • Flip charts • Markers • Basket or sack

STEP 1. INTRODUCTION (10 MINUTES)

Instructions for the facilitator

- Recap on 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.
- Explain that during this lesson we shall focus on harvesting and handling legumes.
- **Methodology**: Group and plenary discussion
- Encourage participants to share their experiences and expertise freely.

STEP 2: WARM-UP DISCUSSIONS HARVESTING AND HANDLING OF LEGUMES (20 MINUTES)

Instructions for the facilitator

- Ask participants what they know about the benefits of legumes.
    - What types of legumes do you grow?
    - What varieties are locally grown and why?
    - What do you think are the benefits of these crops?
- The facilitator thanks the participants for freely sharing their experiences.

STEP 3: GROUP WORK ON HARVESTING LEGUMES IN PLENARY (20 MINUTES)

Instructions for the facilitator

- Divide the participants into 4 groups comprising of 5 – 6 and write the questions below on the flipchart for them to discuss according to their group.

Questions for group A and B

- How do you harvest legumes, e.g., cowpea or beans?
- What are the signs that they are ready for harvesting?
- How do you shell and clean the legumes after harvesting?

Questions for group C and D

- What handling practices of legumes do you know and practice?
- What are some of the precautions that should be considered during handling of legumes?

- Ask the group representatives to present the main points of their discussion and make notes of their points on the flip chart.

STEP 4: GROUP PRESENTATIONS FROM THE DISCUSSION ON THE ABOVE QUESTIONS IN PLENARY (30 MINUTES)

Instructions for the facilitator

- Ask the group representatives to present the main points of their discussion.
- Allow the participants to ask questions and make contributions to the presentations.
- Provide important information by giving a talk to the participants on harvesting and handling of legumes considering what was shared in the presentation.

Harvesting

- Cowpeas, beans and soya beans are harvested when they are mature and dry. They should be placed in the sun for 3-5 days before threshing.
- Groundnuts and Bambara nuts are uprooted and left in the field to dry before plucking. The nuts (pods) are stored in bags or barns until there is need for use.
- Threshing is done when required for use or storage.
- Common beans, soya, and cow peas are threshed by beating the bundles on a tarpaulin or raise platform.
- Groundnuts and Bambara nuts are either shelled by hand or using motorised shellers.
- Care should be taken to ensure that the nuts are well dried thereafter, otherwise, moulds would contaminate the products and produce aflatoxins which are a food safety hazard.

Figure 8 - Farmers harvesting cowpea in the field.

Figure 9 - A farmer placing the harvested cowpeas to dry under the sun for 3-5 days .

Figure 10 - Farmers threshing cowpea or beans with sticks in the bag on the ground.

Figure 11: Group of farmers shelling ground nuts and Bambara nuts using their hands.

Handling

- The dry legumes are unshelled and removed from the Covers.
- After threshing the cowpea/beans and nuts are winnowed to remove chaff and dirt.
- Heavy foreign material can also be removed by using a wire mesh or sieve or with hands.
- To enhance the quality and appeal of the commodity, cowpea/beans and other legumes are sorted to remove damaged or shrivelled grains. Grading can further be done according to colour, size, and variety.
- Sorting and grading will enable the crop to be sold at much high prices.
    - Drying of Legumes prior to storage is one of the most critical post-harvest steps that must always be done.
    - Low Moisture ensures that bacterial and fungal activity in the legumes is kept as low as possible.
- During storage, commodities should be kept as dry as possible, by promoting air circulation thus preventing moisture build up.

Figure12: A farmer cleaning cowpeas/beans by winnowing.

STEP 5: SUMMARY (10 MINUTES)

Instructions for the facilitator

- Allow the participants to ask questions for any clarifications and share their own experiences.
- Ask participants to share the highlight of what they have learnt during the lesson and how they will use it.
- Consolidate and summarize the discussion.

LESSON 2: PROCESSING AND PRESERVATION OF COWPEAS/BEANS AND OTHER LEGUMES.

	**LEARNING OBJECTIVES** 1. To know how legumes can be processed and preserved
	**TIME** 1 hour
	**TRAINING MATERIALS** • Flip charts • Markers • Assorted legumes (cowpeas, beans, groundnuts, bambara nuts, pigeon peas).

STEP 1. INTRODUCTION (10 MINUTES)

Instructions for the facilitator

- Recap on 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.
- Explain that during this lesson we shall focus on harvesting and handling of legumes.
- **Methodology:** Discussion in plenary
- Encourages the participants to share their experiences and expertise freely.

STEP 2: WARM-UP DISCUSSIONS PROCESSING OF LEGUMES (15 MINUTES)

Instructions for the facilitator

- Ask participants about their personal experience regarding processing and preservation of legumes and share in plenary.
    - What products can you make after processing cowpeas, beans, soya beans, ground-nuts, pigeon peas and Bambara nuts?
    - What do you think are the benefits of processing and preserving legumes?
- The facilitator thanks the participants for freely sharing their experiences.

STEP 3: DISCUSSION IN PAIRS ON PROCESSING AND PRESERVATION OF COWPEAS/BEANS IN PLENARY (25 MINUTES)

Instructions for the facilitator

- Ask participants to be in pairs to discuss the following questions. Ask the volunteers to share their opinions about processing and preservation of legumes such as cowpeas, beans, soya beans, groundnuts, pigeon peas and Bambara nuts.
    - What methods do you use to process legumes?
    - What methods do you use to preserve legumes?
- Provide important information by giving a talk to the participants on processing and preservation of legumes.

Processing cowpeas/beans

- The processing of cowpeas/beans and other legumes at household level is very similar in many ways.
- All require a pre-cooking to soften the grains and make it tender. The final cooking is done to added ingredients such as salt, cooking oils to enhance the flavour.
- Cooking is key in deactivating anti nutritional factors in beans such as trypsin inhibitors and tannins.
- To make bean powders, beans is semi cooked, cooled, pounded and sieved. The powder can then be stored.

Cooking.

- Cowpeas and common beans (e.g., Kabulangeti, Solwezi beans etc.), is boiled before it can be consumed as a soup or relish.

Cowpea/Bean powder making procedure.

- Pre-cooked cowpea/beans or semi cooked (semi boiled) can be dried in a Solar dryer or raised rack and pounded into powder to be used in porridge or rice as an ingredient.
- To process into powders, cowpea/beans should be properly pre-cooked.
- Cooking should be stopped before it forms gravy/stew for proper drying.
- A bit of salt or spices could be added.
- No cooking oils or tomatoes must be added at this stage. Adding oils will affect the drying process and cause rancid reactions, thus affecting quality and safety of the powdered cowpea/beans.
- After drying to crispy, the cowpea/beans could be further processed into powder or could be reconstituted by mild cooking adding tomatoes and spices to taste.
- The powdered cowpea/beans can be preserved by placing them in airtight jars and can be stored up to 90 days.

Figure13: A farmer processing precooked cowpea/bean.

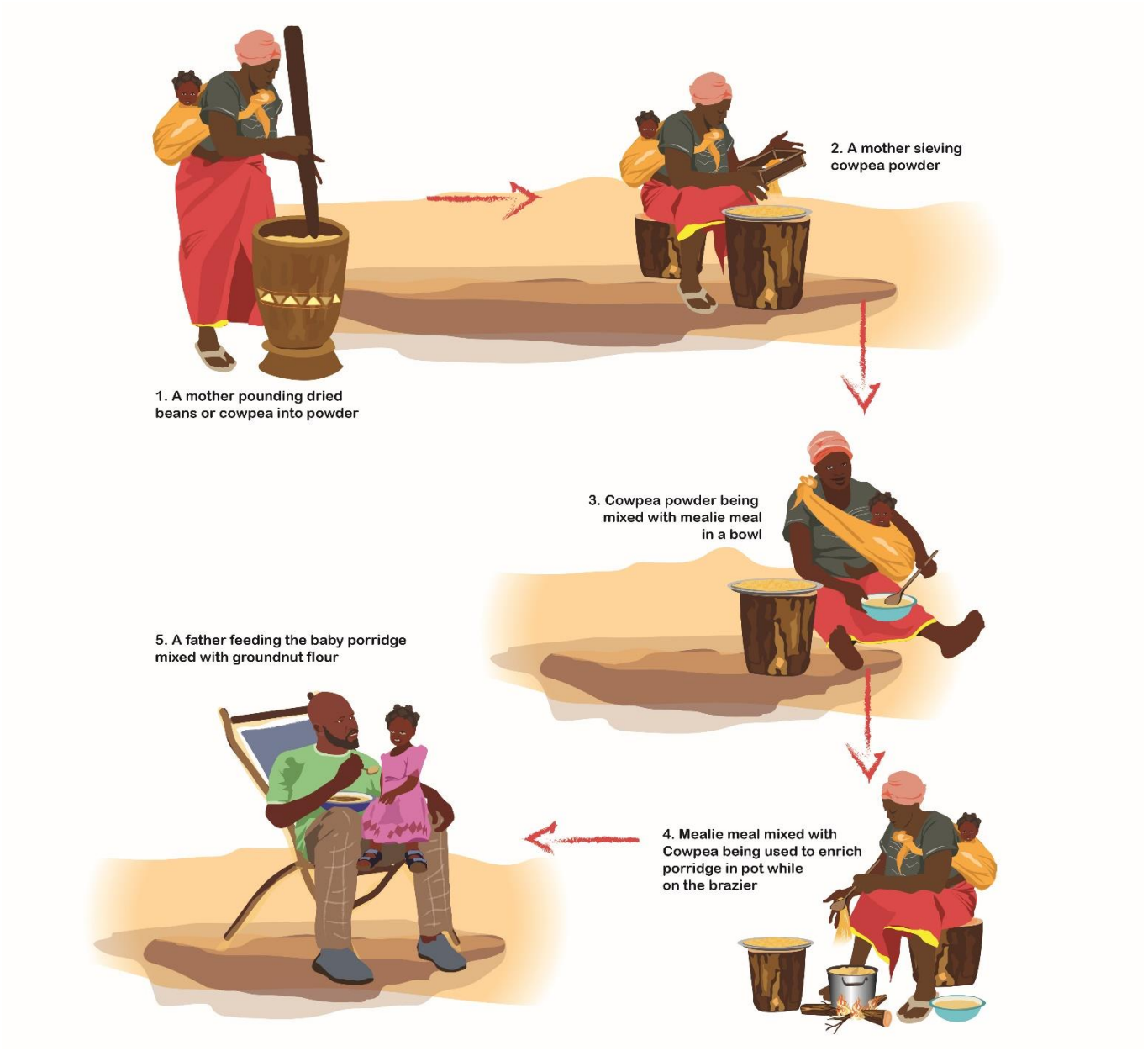

Figure 14 - Further processing of precooked cowpea/beans and father feeding a child

Processing of groundnuts

- Groundnuts are one of the most important legumes grown in Zambia mainly for their high oil and protein content.
- As a result, groundnuts are processed into high value products including peanut butter and edible oils among others.
- Groundnuts must first be selected and sorted for the best quality before processing.
- Ensure that all moulded or rotten seeds are removed to reduce the risk of aflatoxins.
- Groundnuts are high in fibre, proteins and are cholesterol free. Groundnuts also have Omega-3 fatty acids and have low saturated fats.
- At household level, groundnuts are processed into peanut butter, cooking oils, and a variety of both cooked and roasted groundnuts snacks.

- Dry groundnuts powders are used to cook vegetables like “Chibwabwa” or pumpkin leaves in what is locally called “Ifisashi” (mixture of pumpkin leaves and pounded groundnuts). This is basically vegetables cooked with dry groundnuts powders to enhance the protein content (nutritional content) and enrich the flavour of vegetables.

Figure 15: A father feeding their children porridge enriched with cowpea/beans powder.

Peanut Butter making procedure.

- Clean, sorted and dry groundnuts are roasted to a brown colour either using a pan (small scale) or using a roasting machine (industry), until the brown colour is reached.
- Brown colour is used to control the degree/extent of roasting and is an effective quality control check.
- This must be followed by cooling the groundnuts quickly by spreading on a clean sack or wire mesh raised off the ground at least by 45cm.
- The groundnuts are then pounded using mortar and pestle (small domestic scale) or using a groundnuts butter making machine.
- A little salt and or emulsifiers are then blended into the paste and the groundnuts is stored in 500g to 1000g jars for use.
- Emulsifiers are used mainly by commercial producers of peanut butter to stop the oil from separating from the paste – this improves the product quality.
- The products can be consumed by smearing onto bread or adding to porridges and some vegetable soups.

Figure 16 - Making of groundnuts butter (Inchimpondwa)

Processing of groundnuts into powders.

- Groundnuts are processed at domestic level into fine powders by pounding them using a mortar and pestle.
- Clean groundnuts are used for making powder.
- The pounding is done after the groundnuts have been dried adequately in the sun.
- The powders are sieved using a sieve and placed in an airtight plastic bags or bucket for use in cooking some relish such as cowpea leaves, pumpkin leaves, kapenta, sweet bean leaves among other foods.
- This helps improve the nutrition profile of the different foods cooked in this way.
- Groundnuts can also be soaked in water or lightly boiled and the skins removed by hand.
- The nuts can further then be fried or spiced/seasoned for consumption or packed and stored in an airtight plastic bag or bottles.

Figure 17 - Examples of products from the processing of ground nuts.

Figure18: A farmer pounding ground nuts in a traditional mortar to make peanut butter.

Processing of soya beans into flour

- The first thing is to have the Soya beans cleaned and sorted. All stones and all foreign matter must be removed.
- Soya beans should then be roasted golden brown on a pan to remove the chemical content which is harmful to humans.
- Roasted soya is then milled into a fine flour by pounding and sieving to produce fine flour.

- The flour can be used to make porridges. 1 portion of soya flour cup can be mixed with 3 portions of mealie meal.
- The cooked soya porridges can be served by adding other ingredients like sugar or honey and a pinch of salt to give it flavour and taste. Adding milk or some lemon juice improves the taste.

Figure19: Farmers pounding soya beans and sieving it to obtain fine flour.

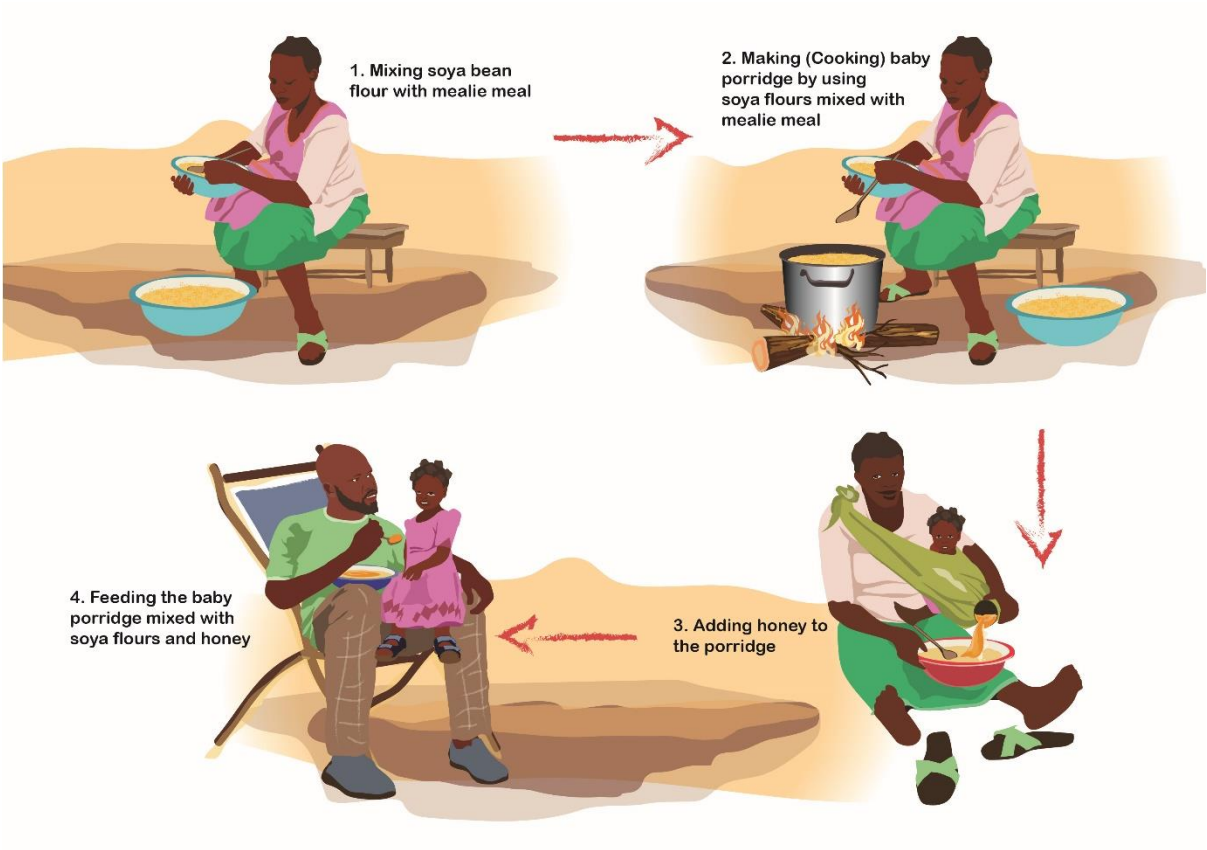

Figure 20 - Soya beans being used for feeding (nutritious meal)

Table: Average amount of time of wet or dry heating for different legumes

Name of Legume	Boiling time (minutes)	Roasting time (time)
	Wet	Dry
Soybeans	45	15
Cowpeas	20	10
Groundnuts	20 (hot water)	15
Bambara nuts/beans	45	15

STEP 4: SUMMARY (5 MINUTES)

Instructions for the facilitator

- Allow the participants to ask questions for any clarification and share their own experiences.
- Ask participants to share the highlight of what they have learnt during the lesson and how they will use it.
- Consolidates and summarizes the discussion.

LESSON 3: STORAGE OF COWPEAS/BEANS AND OTHER LEGUMES.

	**LEARNING OBJECTIVES** 1. To know and understand how Cowpea/beans can be stored. 2. To gain knowledge on different methods of storage
	**TIME** 1 hour 30 minutes.
	**TRAINING MATERIALS** • Cowpea/beans • Plastic containers or buckets • Hermatic bags

STEP 1: INTRODUCTION (10 MINUTES)

Instructions for the facilitator

- Recap on the main points from the previous lesson by asking the participants the following question.
  - What do you remember from the previous lesson?
- Explain that today we shall focus on storage of cowpea/beans.
- **Methodology:** Group work, presentation and practical exercise
- Encourage participants to share their experiences and expertise freely.

STEP 2: DISCUSSION IN GROUPS ON STORAGE OF COWPEA/BEANS (30 MINUTES)

Instructions for the facilitator

- Divide the participants into small groups of 5 – 7 and ask them to discuss the questions below on storage.
  - What are the precautions to consider before storing cowpeas/beans?
  - What methods do you know which are used for storage of cowpea/beans?
  - How do you store cowpea/beans after drying and why?
- Ask the group representatives to present their main points of discussion.

STEP 3. GROUP PRESENTATIONS FROM THE DISCUSSIONS IN PLENARY. (30 MINUTES)

Instructions for the facilitator

- Ask the group representatives to present the points of their discussion on cowpea/beans storage.
- Allow the participants to ask questions and make contributions on the presentations.
- Provide important information by giving a talk to the participants on storage of cowpea/beans considering what was shared in the plenary.

What to consider before storage of cowpea/beans

- Grain must be cleaned of defects and foreign matter and be of correct moisture content.
- It is critical that a farmer decides how much crop to store for a short time and a longer time. This will affect the type of storage equipment selected.
- Clean out the storeroom thoroughly before a new crop is loaded. Old residues should be removed and burned.
- Only well-dried and properly cleaned cowpea/beans should be stored.
- The safe moisture content for storage is 7-8%; High moisture content and high humidity during storage decrease quality of grain in storage.

Appropriate storage methods of cowpea

- There are various equipments for storage and these include PIC bags, plastic containers, buckets and clay pots are also used.

1. **Using Airtight (hermetic) Storage Units**
    - Airtight storage provides excellent insect control and stops the grain from reabsorbing moisture from the atmosphere.
    - When closed, the oxygen in the storage unit quickly expires (the oxygen is enough for grain respiration but not insects trapped inside).
    - All insects, mould and fungi will die quickly without oxygen.
2. **Plastic (hermetic) Storage bags**
    - Bags can store up to 50 or 100kg of grain. Hermetic Storage Bags are placed inside an outer bag to protect the hermetic internal bag against damage.
    - Hermetic Storage bags are re-usable for about 3 years.
3. **Plastic containers**
    - Cowpea/beans can be stored in a bucket or plastic container.
    - The container should be stored in a cool dry place and well-ventilated dry place.

- Keep grain away from moisture and rodents. Store on raised platform e.g. on palates or logs.

Figure 21: A family stacking bags of cowpea/beans on a raised surface

Figure 22: Buckets for storing cowpeas/beans.

STEP 4: PRACTICAL EXERCISE ON STORAGE OF COWPEA/BEANS (40 MINUTES)

Instructions for the facilitator

- Identify the household where to do practical exercise on storage of cowpea/beans before-hand. Make sure all the required materials and equipment are available in advance.
- Identify the participants who can demonstrate the different methods of storage before-hand.
- Then ask the identified participants to demonstrate the storage. 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)

Instructions for the facilitator:

- Allow the participants to ask questions for any clarification.
- Ask participants to share the highlight of what they have learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.

MODULE 3: POST HARVEST MANAGEMENT PRACTICES OF ORANGE FLESHED SWEET POTATOES (OFSP).

This module aims at equipping farmers with the adequate and necessary skills for harvesting and post-harvest handling of Orange Fleshed Sweet Potatoes (OFSP). The module discusses post-harvest handling including processing, preservation and storage of OFSP.

These lessons include:

- Harvesting of OFSP.
- Processing and preservation of OFSP
- Storage of OFSP

LESSON 1: HARVESTING AND HANDLING OF OFSP.

	**LEARNING OBJECTIVES** 1. To know and understand signs of a mature OFSP. 2. To know the disadvantages of delayed harvesting of OFSP.
	**TIME** 1 hour 20 Minutes
	**TRAINING MATERIALS** • Hoe • basket or sack

STEP 1: INTRODUCTION (10 MINUTES)

Instructions for the facilitator

- Recap on the previous lesson by asking participants to share what they have learnt in plenary and add the key points which may not be mentioned.
- Explain that today we shall focus on harvesting of OFSP.
- **Methodology:** Discussions and Practical.
- Encourage participants to share their experiences and expertise freely.

STEP 2: DISCUSSION ON HARVESTING OF OFSP IN PLENARY (20 MINUTES)

Instructions to the facilitator

- Ask the participants to be in pairs of two with their neighbor and discuss the following questions:
  - When is the right time to harvest OFSP?
  - What are the signs for mature OFSP?
  - What are the disadvantages of delayed harvesting of OFSP?
  - What should we consider to avoid damaging and spoiling OFSPs during and after harvesting?
- Invite up to 5 participants to share the point of the discussions and further ask other participants to add.
- Allow the participants to ask questions and make contributions on the presentation.
- Provide important information by giving a talk to the participants on harvesting of OFSP considering what was shared in the presentation.

Best time to harvest OFSP.

- Sweet potatoes continue to grow if environmental conditions remain favorable.
- The harvest time is determined by the expected root size. This implies that OFSP should be harvested when the bulk of the roots have reached the desired size for consumption or market.
- In some varieties, harvesting can be done within 3-4 months while late maturing varieties may take as long as 6 months.
- The harvesting of sweet potatoes is normally done from around April to July depending on the time of planting.
- Signs of maturity include yellowing of leaves, drying of vines, releasing of sap from mature roots and cracking of ridges though this could also be due to moisture stress or soil related issues.
- Piece meal harvesting is done where bigger roots are removed from the plant while smaller ones are left to continue growing. Piece meal harvesting means that after harvesting the bigger roots, the remaining smaller ones are planted back in the soil with the vines.

Caution during harvesting

- Avoid cutting or bruising the roots as this would lower their market value by making the roots prone to pathogen infection.
- Harvested roots should be dried for a period of six hours in the shade to recover from any wounds, to release excess moisture, and to ensure that they'll last longer in storage.

Disadvantages of delayed harvesting of sweet potatoes

- Delayed harvesting encourages weevil infestation, mole attacks and vulnerable to human theft.

Figure 23-Harvest OFSP

STEP 3: PRACTICAL EXERCISE ON HARVESTING OF OFSP (40 MINUTES)

Instructions for the facilitator

- Identify the field where to do practical exercise on harvesting of OFSP beforehand. Make sure all the required materials and equipment are available in advance.
- While in the field, ask volunteers to demonstrate how harvesting of OFSP is 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)

Instructions for the facilitator

- Allow the participants to ask questions for any clarification.
- Ask participants to share the highlight of what they have learnt during the lesson and how they will use it.
- Consolidates and summarizes the main discussion content of the lesson.

LESSON 2: PROCESSING AND PRESERAVATION OF OFSP.

LEARNING OBJECTIVES

1. Know how OFSP can be processed.
2. To demonstrate different methods of processing OFSP.
3. To know and understand how OFSP can be preserved.
4. To gain knowledge on different methods of preservation of OFSP.
5. To gain knowledge on storage methods of OFPS.

TIME

1 hour 40 Minutes

TRAINING MATERIALS

- Different sizes of OFSP roots
- Pots
- Plates
- Braziers
- Water
- Knives
- Cooking sticks
- Salt
- Solar dryers/rack
- Rack

STEP 1: INTRODUCTION (10 MINUTES)

Instructions for the facilitator

- Recap on the previous lesson by asking participants to share what they learnt in plenary and add the key points which may not be mentioned.
- Explain that today we shall focus on processing and preservation of OFSP.
- **Methodology:** Discussions and Practical.
- Encourage participants to share their experiences and expertise freely.

STEP 2: DISCUSSION ON PROCESSING OF OFSP IN PLENARY (20 MINUTES)

Instructions for the facilitator

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

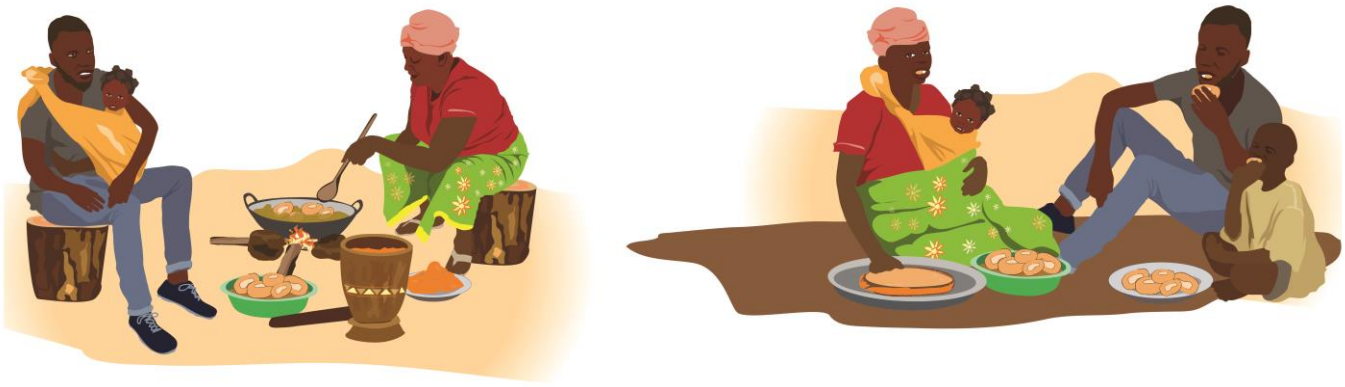

Figure 24- Left: A mother making OFSP fritters; Right: a family eating the fritters.

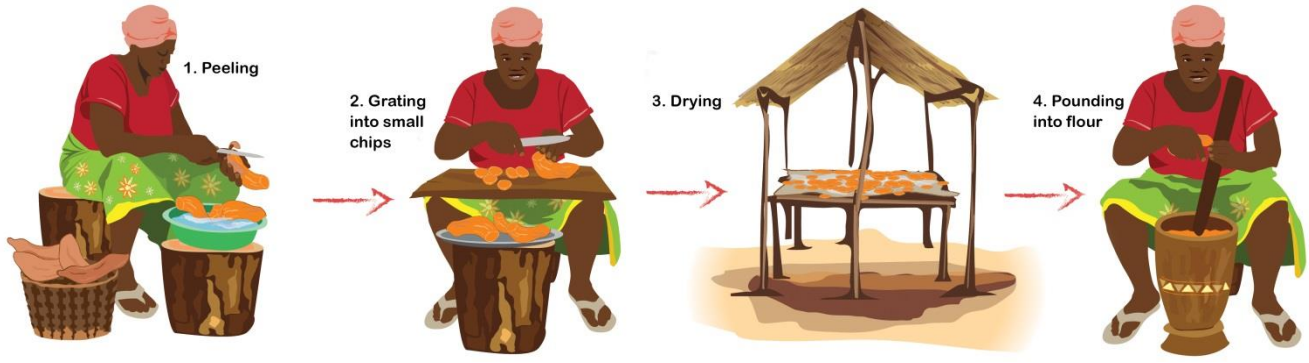

Figure 25-Processing OFSP into Chips and pounding into flour.

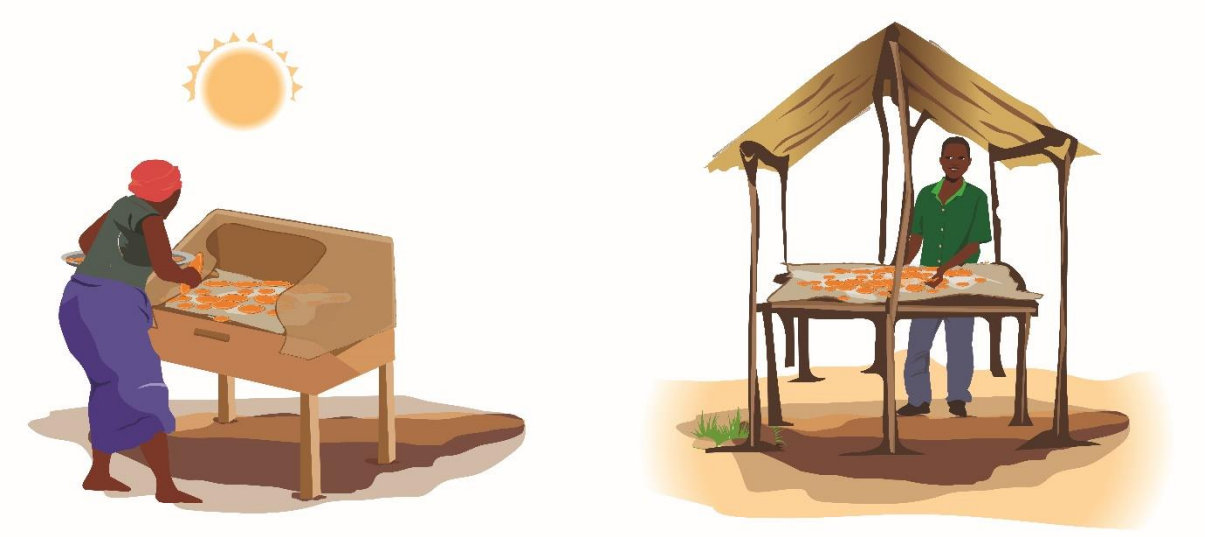

Figure 26 - Improved drying methods (Solar drying and drying under the shade)

Processing of OFSP.

- This involves sorting, grading, cleaning, peeling, cooking and drying of OFSP for immediate or future consumption or for the purpose of adding value and marketing of fresh potatoes.
- The fresh roots can be boiled or roasted and further processed by mashing into puree feeding children or adults as source of vitamin A.
- In addition, a range of products including breads, chapattis, cakes, juices, porridge, etc., can be made.

STEP 3: DISCUSSION ON PRESERVATION OF OFSP IN PLENARY (20 MINUTES)

Instructions for the facilitator

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

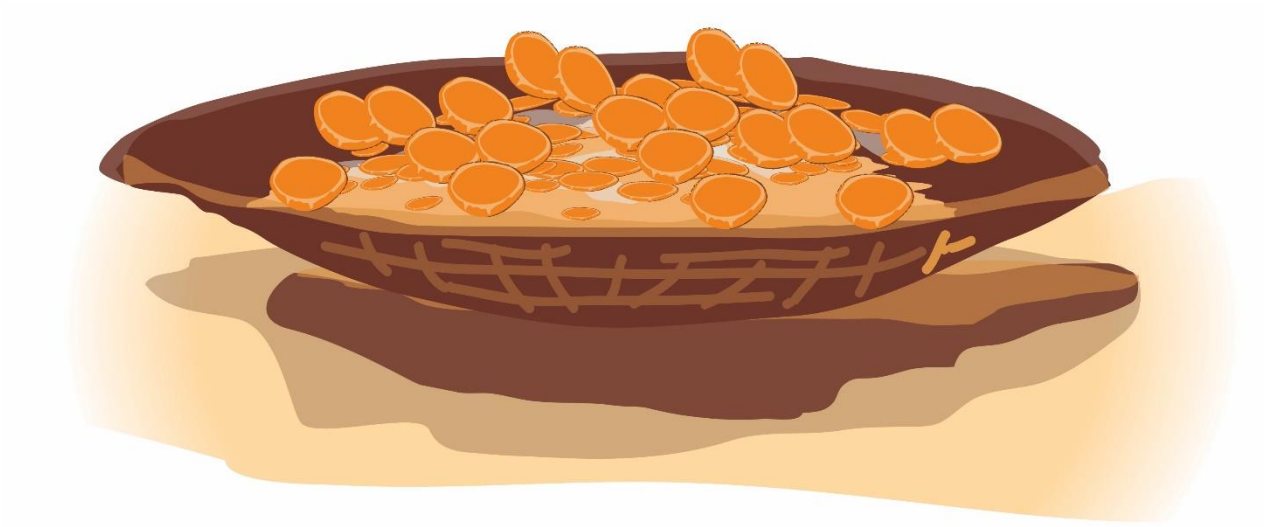

Figure 27-Dried Boiled Sweet Potatoes

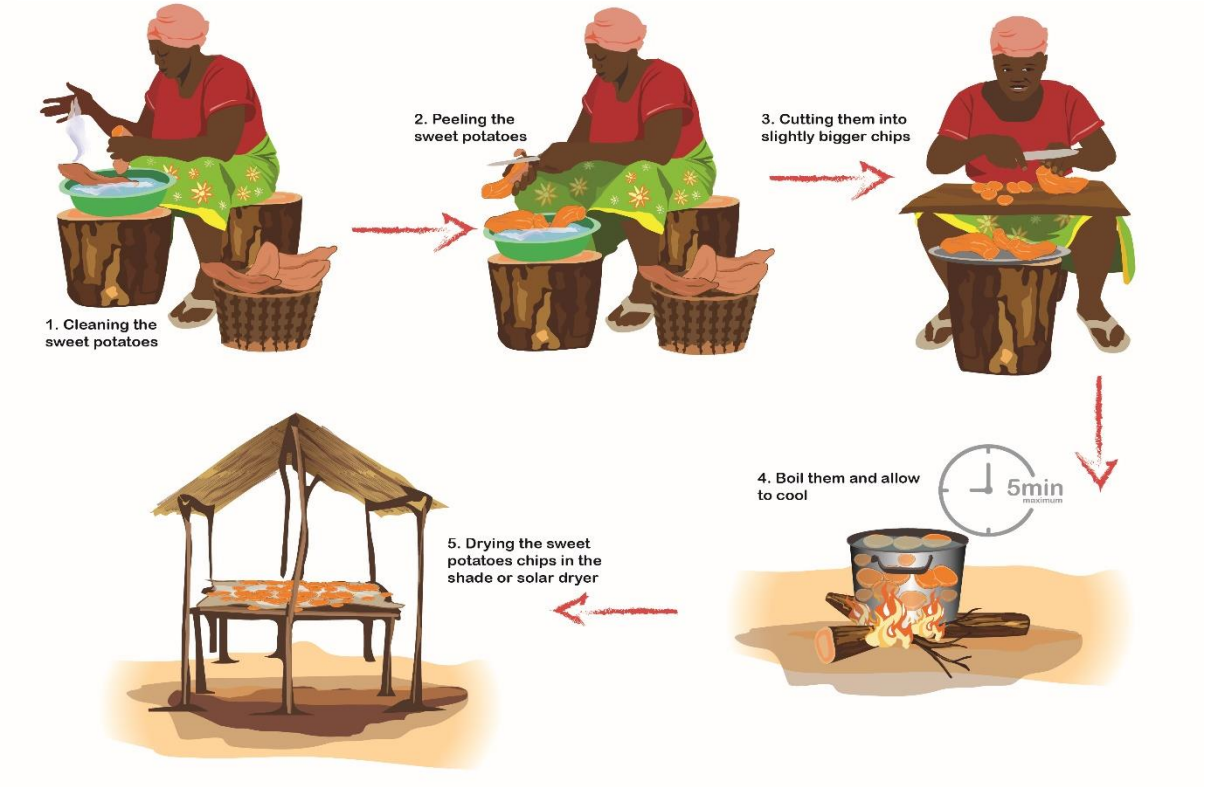

Figure 28 - Process of drying OFSP.

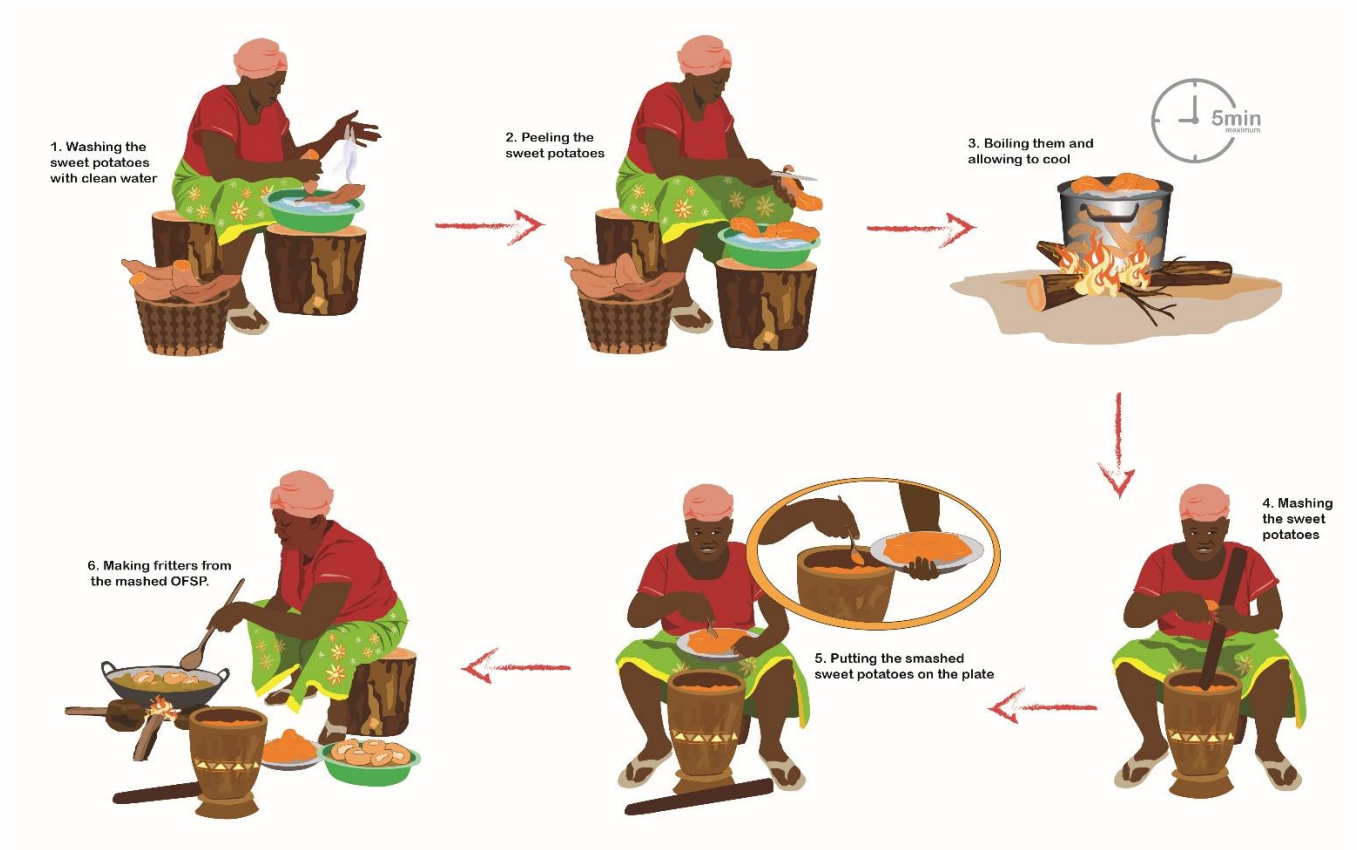

Figure 39 - Process of making OFSP fritters.

Figure 30- Left: A mother making OFSP fritters; Right: a family eating the fritters.

Preservation of OFSP

- Preservation is the process of keeping OFSP from decay and spoilage by maintaining the quality until they are consumed or sold.
- The fresh roots can also be cut or pounded into chipped or small pieces and dried using a solar dryer or in the shade and kept as an important food stock to cook and eat during the year or made into flour, cereal (flakes) or noodles.

STEP 4: PRACTICAL EXERCISE ON PROCESSING AND PRESERVATION OF OFSP (40 MINUTES)

Instructions for the facilitator

- Identify the household where to do practical exercises on processing and preservation of OFSP 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 OFSP. 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)

Instructions for the facilitator

- Allow the participants to ask questions for any clarification.
- Ask participants to share what they found most interesting about what they have learnt during the lesson and how they will use it.
- Consolidates and summarizes the main discussion points.

LESSON 3: STORAGE OF OFSP.

<table>
<tr><td>  </td><td>LEARNING OBJECTIVES
1. To know and understand how OFSP can be stored.
2. To gain knowledge on different methods of storage for OFSP.</td></tr>
<tr><td>  </td><td>TIME
1 hour 40 Minutes</td></tr>
<tr><td>  </td><td>TRAINING MATERIALS
• Hoe
• Sweet potato
• Clean dry grass or dry sticks
• Saw dust.
• Ashes
• Mat or any metal sheet
• Newspaper
• Wheelbarrow</td></tr>
</table>

STEP 1: INTRODUCTION (10 MINUTES)

Instructions to the facilitator

- Recap on the main points from the previous lesson by asking the participant the following question.
    - What do you remember from the previous lesson?
- Explain that today we shall focus on storage of OFSP.
- **Methodology:** Group work and practical exercises.
- Encourage participants to share their experiences and expertise freely.

STEP 2: DISCUSSION IN GROUPS ON STORAGE OF OFSP (15 MINUTES)

Instructions for the facilitator

- Divide the participants into small groups of 5 – 7 and ask them to discuss the following questions below on storage.
    - Which methods do you know which are used for storage of sweet potatoes?
    - How do you store sweet potatoes after harvesting and why?
- Ask the group representatives to present their main points of discussion.

STEP 3. GROUP PRESENTATIONS FROM THE DISCUSSIONS IN PLENARY (20 MINUTES)

Instructions for the facilitator

- Ask the group representatives to present the main points of their discussion on OFSP storage.
- Allow the participants to ask questions and make contributions on the presentations.
- Provide important information by giving a talk to the participants on storage of OFSP considering what was shared in the in plenary.

Storage of OFSP

- If storage is desired after harvesting, the roots clean and should be sorted out by removing bruised or damaged OFSP. Such roots should be left in the sun to cure naturally for six hours before storage.
- The roots should then be sprayed with wood ash and stored in accordance with any of the following procedures:

Pit storage using ashes.

- Dig a pit of 0.5 m x 0.5 m. Line the bottom of the pit with clean dry grass or dry sticks. Pack cured and ash-treated roots in the pit up to 15cm from the upper ground level. Cover lightly with dry grass and topsoil.
- Finally, cover with a mat or any metal sheet to keep away rainy water, in case of rain.

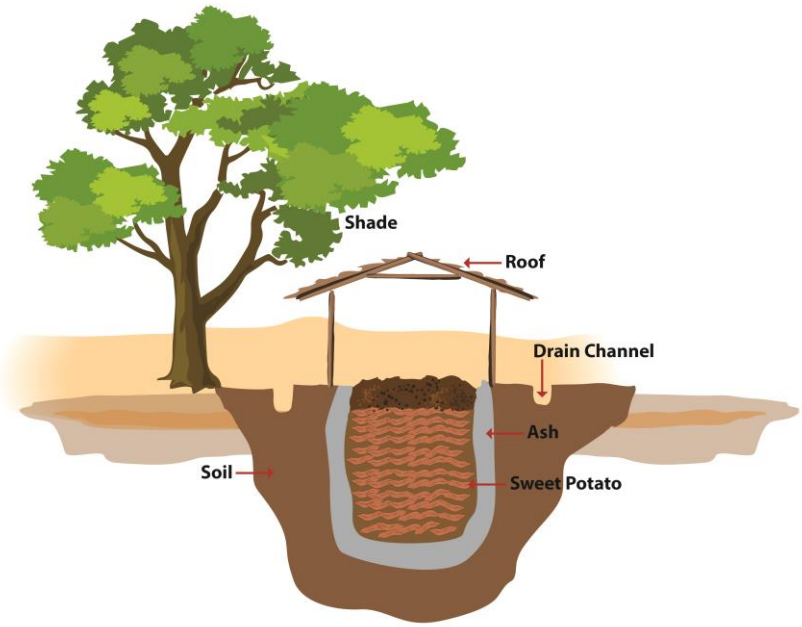

Figure 31 - Ash Pit Storage

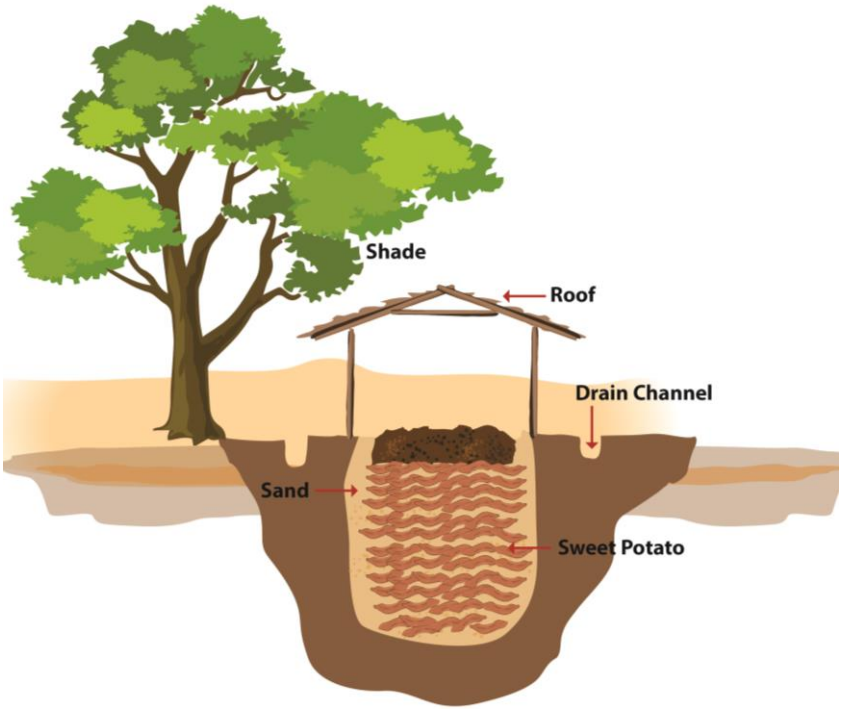

Figure 32 - Saw Dust Pit storage.

Storage in container using sand.

- Get a clean and dry polythene container that can accommodate the quantity of roots available. Line it with either a dry newspaper or grass at the bottom.
- Put a layer of dry sand followed by a layer of OFSP roots. Continue this process until the container is filled with a final layer of sand.
- The container can then be protected from moisture getting to the roots by covering it. The container can then be placed in a cool dry place.

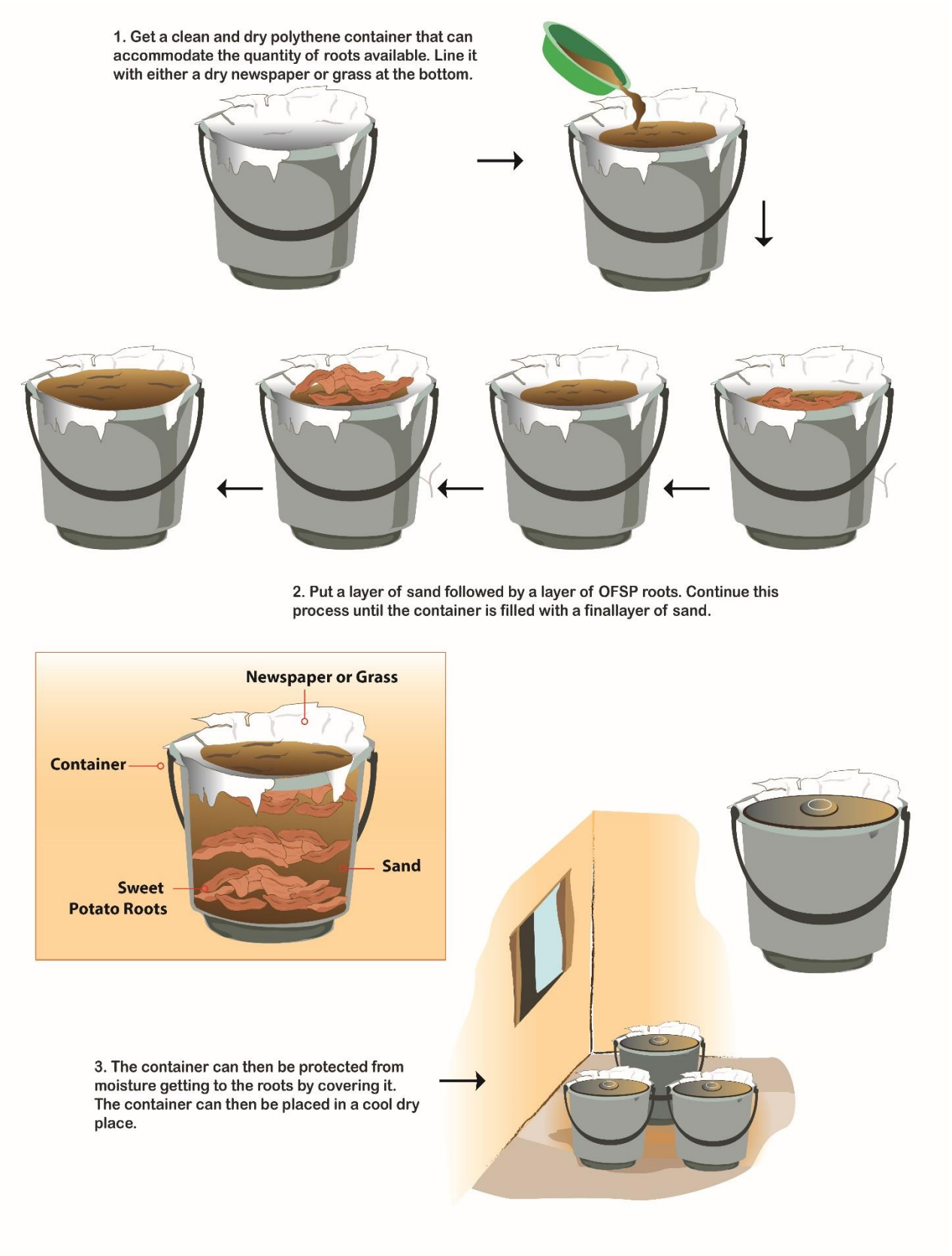

Figure 33 - Storage in containers

STEP 4: PRACTICAL EXERCISE ON STORAGE OF OFSP (45 MINUTES)

Instructions for the facilitator

- Identify the household where to do practical exercises on storage of OFSP beforehand. Make sure all the required materials and equipment are available in advance.
- Identify the participants who can demonstrate the different methods of storage before-hand.
- Then ask the identified participants to demonstrate the storage practice. 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)

Instructions for the facilitator

- Allow the participants to ask questions for any clarification.
- Ask participants to share the highlight of what they have learnt during the lesson and how they will use it.
- Consolidates and summarizes the main discussion content of the less.

MODULE 4: POST HARVEST MANAGEMENT PRACTICES OF ORANGE MAIZE

This module aims at equipping farmers with the adequate and necessary skills for harvesting and post-harvest handling of orange maize. The module discusses post-harvest handling including processing and storage.

These lessons include:

- Harvesting of orange maize.
- Processing and preservation of orange maize
- Storage of orange maize

LESSON 1: HARVEST AND HANDLING OF ORANGE MAIZE.

	**LEARNING OBJECTIVES** 1. To know and understand indicators of a mature orange maize. 2. To know and understand the good practices in harvesting and handling of orange maize. 3. To know the disadvantages of delayed harvesting of orange maize.
	**TIME** 1 hour 20 Minutes
	**TRAINING MATERIALS** • Flip charts • Markers • Samples of good and bad quality

STEP 1: INTRODUCTION (10 MINUTES)

Instructions for the facilitator

- Recap on the main points from the previous lesson by asking the participants the following question.
  - What do you remember from the previous lesson?
- Explain that today we shall focus on harvesting and handling of orange maize.
- **Methodology:** Group work, presentation and practical exercise
- Encourage participants to share their experiences and expertise freely.

STEP 2: DISCUSSION IN GROUPS ON HARVESTING AND HANDLING OF ORANGE MAIZE (30 MINUTES)

Instructions for the facilitator

- Divide the participants into small groups of 5 – 7 and ask them to discuss the following questions below on storage.
  - Which methods do you know is used to determine moisture content of orange maize before harvesting?
  - What are the precautions to consider during harvesting of orange maize?
  - What practices of handling orange maize do you know and practice?
  - What are some of the precautions that should be considered during handling?

STEP 3. GROUP PRESENTATIONS FROM THE DISCUSSIONS IN PLENARY. (30 MINUTES)

Instructions for the facilitator

- Ask the group representatives to present the main points of their discussion on harvesting of orange maize.
- Allow the participants to ask questions and make contributions on the presentations.
- Provide important information by giving a talk to the participants on harvesting of orange maize considering what was shared in the in plenary.

Methods of checking moisture content

- **Shaking grain in a tin and judging from the sound made:** grain with high moisture content gives a dull sound compared to the sharp sound made by dry grain.
- **Pushing the hand into grain bulk**: wet grain offers more resistance to penetration than dry grain.
- **Biting with teeth**: Dry maize grain is hard and cracks when you bite with teeth, while grain with high moisture content is soft, the teeth penetrates when you try to bite.
- **Salt method:** Take a small sample of the maize grain mixed with dry salt, put it in a clean dry jar, shake it vigorously for several minutes and allow it to settle. If salt becomes wet and sticks on the wall of the jar, then the grain has high moisture content above 15% and therefore it needs to be dried further.

NOTE: Prepare yourself before harvesting, make sure you have all the necessary equipment, know where the drying and shelling will be done and how the grain will be stored. Mend all holes in sacks and make sure stores are in good repair.

What to consider before and during harvesting of orange maize.

- Harvest the grain on time when it is fully mature.
- Avoid putting orange maize in direct contact with soils. Use sacks or other materials during harvest.
- Ensure that:
    - the equipments needed for harvest and postharvest activities are available.
    - there is sufficient storage space for the crop.
    - Grain stores and sacks have been thoroughly cleaned before the new harvest arrives so that the residues of the old harvest (last season's crop) are removed from all storerooms and fed to animals or burnt.

Handling of orange maize

- Good hygiene is a very important activity to prevent postharvest losses, the new harvest should never be placed on, or with, grain from the previous season as this will encourage the movement of pests from the old to the newly stored crop.
- The harvest should be transported to the homestead as soon as possible using a wheel-barrow, bicycle or ox/donkey drawn carts and by humans.
- It is important to make sure that the crop is transported in clean and dry containers that do not allow the crop to spill out.
- Dry the grain sufficiently until they attain recommended moisture content for maize grain of 13.5%.
- Ensure to shell/thresh the grain by using the methods that are less damaging to grains.
- Clean the grain by winnowing/sieving to remove chaff and foreign matter.
- Foreign Matter and filth such as maize cob cores, tassels stones, rodent dropping and dead insects must be removed.
- Sort of out the grain by removing the broken ones during shelling or threshing.
- Remove grains damaged by insect pests. Insects make holes in grains that spoils the maize.
- Remove mould damaged grains.

Figure 34 - Orange maize being harvested.

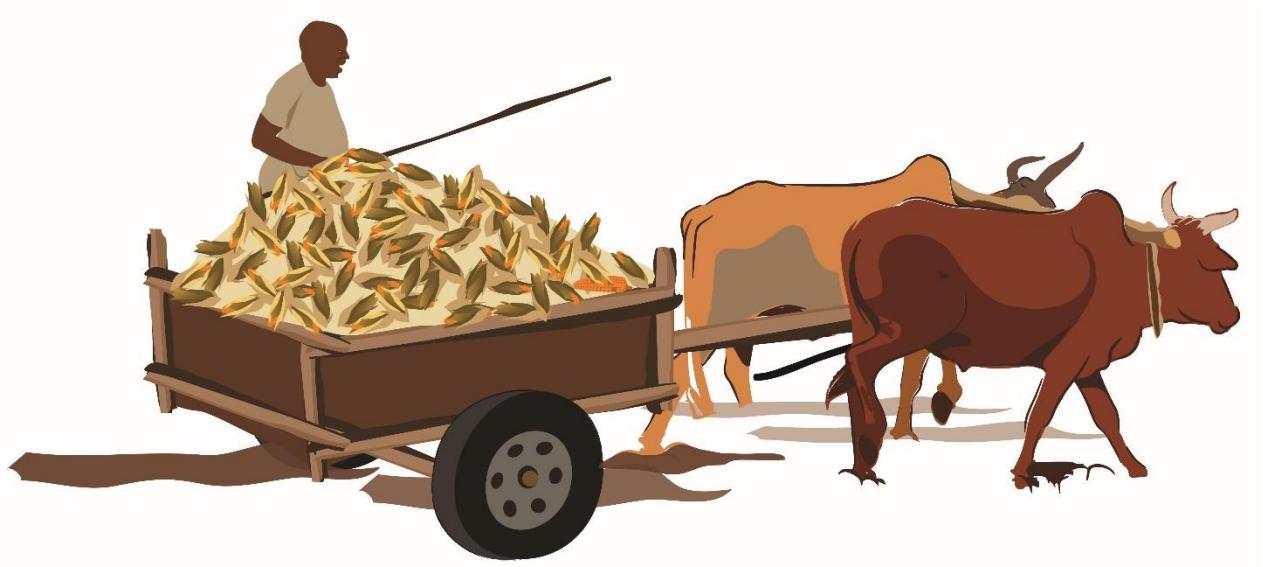

Figure 35 - Ferrying the orange maize using ox cart.

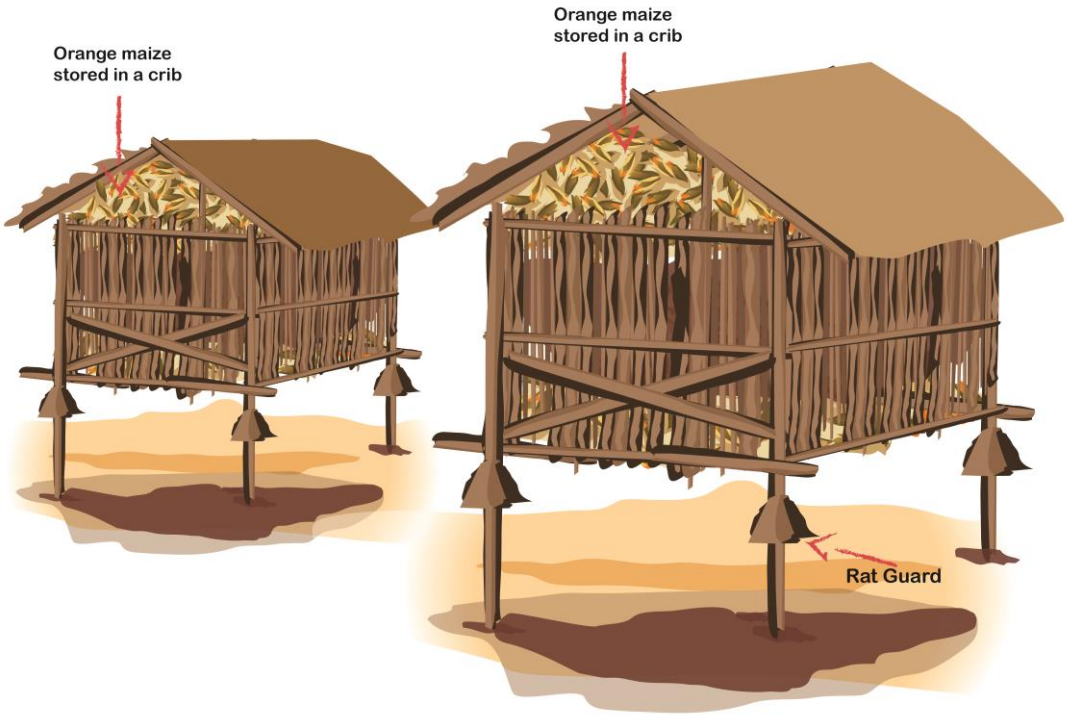

Figure 36- Orange maize stored in the raised crib (granary).

Figure 37 - Shelling orange maize by using hands.

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Figure 38 - Shelling using a motorised Sheller.

Figure 39 - Cleaning the grain using a handheld sieve.

Figure 40– A farmer putting the grain in improved sacks (PICS)

STEP 5: SUMMARY (10 MINUTES)

Instructions for the facilitator

- Allow the participants to ask questions for any clarification.
- Ask participants to share the highlight of what they have learnt during the lesson and how they will use it.
- Consolidates and summarizes the main discussion content of the less.

LESSON 2: PROCESSING AND PRESERAVATION OF ORANGE MAIZE.

	**LEARNING OBJECTIVES** 1. To improve the skills of farmers in the processing and preservation of orange maize.
	**TIME** 1 hour
	**TRAINING MATERIALS** • Flip charts • Markers • Samples of good and bad quality

STEP 1: INTRODUCTION (10 MINUTES)

Instructions for the facilitator

- Recap on the main points from the previous lesson by asking the participant the following question.
    - What do you remember from the previous lesson?
- Explain that today we shall focus on processing orange maize.
- **Methodology:** Discussion in plenary
- Encourage participants to share their experiences and expertise freely.

STEP 2: WARM-UP DISCUSSIONS PROCESSING OF ORANGE MAIZE (10 MINUTES)

Instructions for the facilitator

- Ask participants about their personal experience of processing orange maize.
    - What processed products of orange maize do you know?
    - What are the benefits of processing orange maize?
- The facilitator thanks the participants for freely sharing their experiences.

STEP 3: DISCUSSION ON PROCESSING OF ORANGE MAIZE IN PLENARY (30 MINUTES)

Instructions for the facilitator

- Ask participants what they know about processing of orange maize.
- Ask the following questions and allow participants to raise their hands and share their opinions:
    - How is orange maize processed?
    - How are processed products consumed?
- Provide important information by giving a talk to the participants on processing of orange maize considering what was shared in the in plenary.

Processing of orange maize

Primary processing of orange maize

- This involves the immediate post-harvest handling practices such as drying and shelling. Care should be taken to reduce accumulation of moulds /aflatoxins during this stage.
- Drying should be done either using dryers or under the shade (to minimize loss of vitamins (carotenoids) which are sensitive to light).
    - Ensure that the grain is adequately dry according to the recommended moisture content.

Secondary Processing of orange maize

- This involves the process of changing the form of the maize kernel to facilitate its subsequent use.
- The maize is conditioned (addition of water) before milling or pounding to derive products such as samp.
- Orange maize can be pounded or milled and sieved to give different products such as maize bran, grits, meal and samp.

The following are the steps involved in secondary processing:

- Raw materials (fully ripe grain, free from moulds, pest).
- Clean (By hand to remove leaves, stones).
- Condition (Add cold water to soften grain).
- Dehull (Use dehuller) optional.
- Mill (use a hammer mill/mortar).
- Pack (In sacks or plastics).

Tertiary processing of orange maize

- This involves the conversion of uncooked materials into products and food combinations for human consumption.
- Processed maize products are utilized using different methods and food combinations to improve household diets.
- Minimise food preparation methods that can lead to loss of the heat sensitive vitamin A e.g., overcooking.
- Food preparation methods that enhance the bioavailability of vitamin A should be encouraged e.g., combination with oil rich crops such as legumes or adding a little oil when cooking.

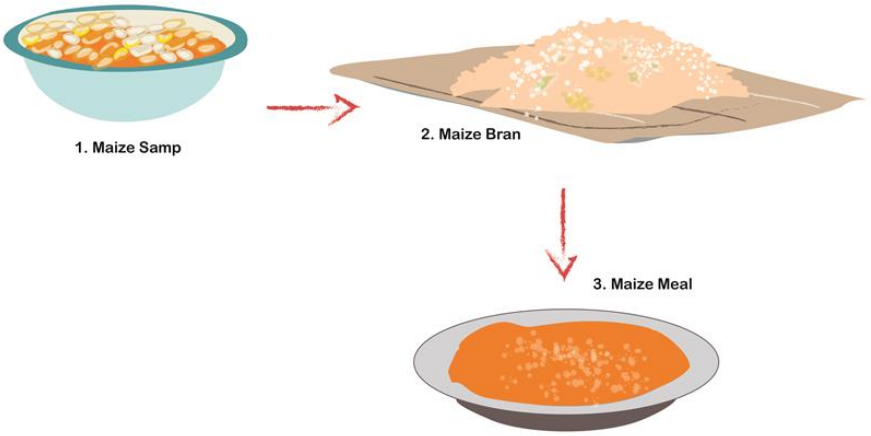

Figure 41 - Orange maize products.

Figure 42- Pounding of orange maize into samp.

Figure 43 – Milling of orange maize into mealie meal using a hammer mill.

Figure 44 – A family eating nshima made from orange maize meal.

STEP 5: SUMMARY (10 MINUTES)

Instructions for the facilitator

- Allow the participants to ask questions for any clarification.
- Ask participants to share the highlight of what they have learnt during the lesson and how they will use it.
- Consolidates and summarizes the main discussion content of the lesson.

LESSON 3: STORAGE OF ORANGE MAIZE.

	**LEARNING OBJECTIVES** 1. To know and understand how orange maize can be stored. 2. To gain knowledge on different methods of storage.
	**TIME** 1 hour 20 minutes
	**TRAINING MATERIALS** • Cowpea • Plastic containers • Hermatic bags

STEP 1: INTRODUCTION (10 MINUTES)

Instructions to the facilitator:

- Recap on the main points from the previous lesson by asking the participant the following question.
    - What do you remember from the previous lesson?
- Explain that today we shall focus on storage of orange maize.
- **Methodology:** Group work, presentation and practical exercise
- Encourage participants to share their experiences and expertise freely.

STEP 2: DISCUSSION IN GROUPS ON STORAGE OF ORANGE MAIZE (30 MINUTES)

Instructions to the facilitator:

- Divide the participants into small groups of 5 – 7 and ask them to discuss the following questions below on storage.
    - What are the precautions to consider before storing?
    - Which methods do you know can be used for storage of orange maize?
    - How do you store orange maize?
- Ask the group representatives to present their main points of discussion.

STEP 3. GROUP PRESENTATIONS FROM THE DISCUSSIONS IN PLENARY. (30 MINUTES)

Instructions for the facilitator

- Ask the group representatives to present the points of their discussion on orange maize storage.
- Allow the participants to ask questions and make contributions on the presentations.
- Provide important information by giving a talk to the participants on storage of orange maize considering what was shared in the in plenary.

What to consider before storage of orange maize

- Grain must be cleaned of defects and foreign matter. Moisture content should be 13% or less.
- It is critical that a farmer decides how much crop to store for a short time and a longer time. This will affect the type of storage equipment selected.
- Clean out the store thoroughly before a new crop is loaded. Old residues should be removed and burned. Only well-dried and properly cleaned orange maize should be stored.
- Ensuring that the crop going into the store is in good condition. The grain should be well dried, well cleaned and an any damaged grain removed.
- Keeping the store in good condition. It should be waterproof, theft proof, sealed off any cracks and in good condition.
- Practicing good storage hygiene. keep everything in and around the store as clean as is practically possible.
- Maintaining the condition of crops and stores throughout the storage season. The store should be quickly repaired if it becomes damaged.

Appropriate storage methods for orange maize

- There are various equipments for storage and this include PICS bags, Metal or plastic silos and raised traditional cribs.

1. **Using Airtight (hermetic) Storage Units**
    - Airtight storage provides excellent insect control and stops the grain from reabsorbing moisture from the atmosphere.
    - When closed, the oxygen in the storage unit quickly expires (the oxygen is enough for grain respiration but not insects trapped inside). All insects, mould and fungi will die quickly without oxygen.

2. **Plastic (hermetic) Storage bags**
    - Bags can store up to 50 or 100kg of grain. Hermetic Storage Bags are placed inside an outer bag to protect the hermetic internal bag against damage.
    - Hermetic Storage bags are re-usable for about 3 years.

3. **Metal or plastic silos**
    - Orange maize can be stored in a basket or plastic container.
    - The container should be stored in a cool dry place and well-ventilated dry place. Keep grain away from moisture and rodents.
    - Store on raised platform e.g. on palates or logs.

STEP 4: SUMMARY (10 MINUTES)

Instructions for the facilitator

- Allow the participants to ask questions for any clarification.
- Ask participants to share the highlight of what they have learnt during the lesson and how they will use it.
- Consolidate and summarize the main discussion points.

Figure 45 - Bags of orange maize being stacked on a raised platform.

LESSON ON MANAGEMENT OF AFLATOXINS.

	**LEARNING OBJECTIVES** 1. To know and understand how to manage aflatoxins effectively in cereals and legumes.
	**TIME** 50 Minutes
	**TRAINING MATERIALS** • Flip charts • Markers • Samples of bad quality maize grain and groundnuts

STEP 1: INTRODUCTION (10 MINUTES)

Instructions to the facilitator

- Recap on the main points from the previous lesson by asking the participants the following question.
    - What do you remember from the previous lesson?
- Explain that today we shall focus on management of aflatoxins.
- **Methodology:** Discussions in plenary.
- Encourage participants to share their experiences and expertise freely.

STEP 2: DISCUSSION ON WHAT AFLATOXINS ARE AND THEIR PREVALENCE IN PLENARY (30 MINUTES)

Instructions for the facilitator

- Show the participants the picture of moulded maize and groundnuts then ask them the following questions:
    - What is aflatoxin? Mention the characteristics.
    - Which crops are most susceptible to aflatoxins and why?
    - What are the dangers/effects of aflatoxins?
    - What measures do you use to control aflatoxins?
    - What other measures can you use to control aflatoxins?
- Write down all the responses on a flip chart or paper and summarize them for the group.

- Provide important information by giving a talk to the participants on storage of orange maize considering what was shared in the in plenary.

Characteristics of aflatoxins

- Aflatoxins are colourless and cannot be detected under normal light. Most often, the fungus that produces them shows up as a surface mould.
- The fungus can be seen under microscope or UV light (basic detection method).
- Aflatoxins are odourless and contaminated food most often does not have any special or bad smell. Sometimes grains can smell mouldy due to fungal contamination when moisture content of the contaminated produce is still high.
- Aflatoxin is flavourless and even food that is dangerously contaminated usually does not have any off or mouldy taste. Sometimes groundnut kernels can have a bitter taste and those should be spit out.
- The only way to know if a food contains aflatoxins is by testing it in a laboratory using advanced technology.
- Commodities regularly contaminated with aflatoxins include: Groundnuts, Maize, Cottonseeds, Tree nuts, Sunflower seeds, Spices, Sorghum, Millet, Rice, and wheat.

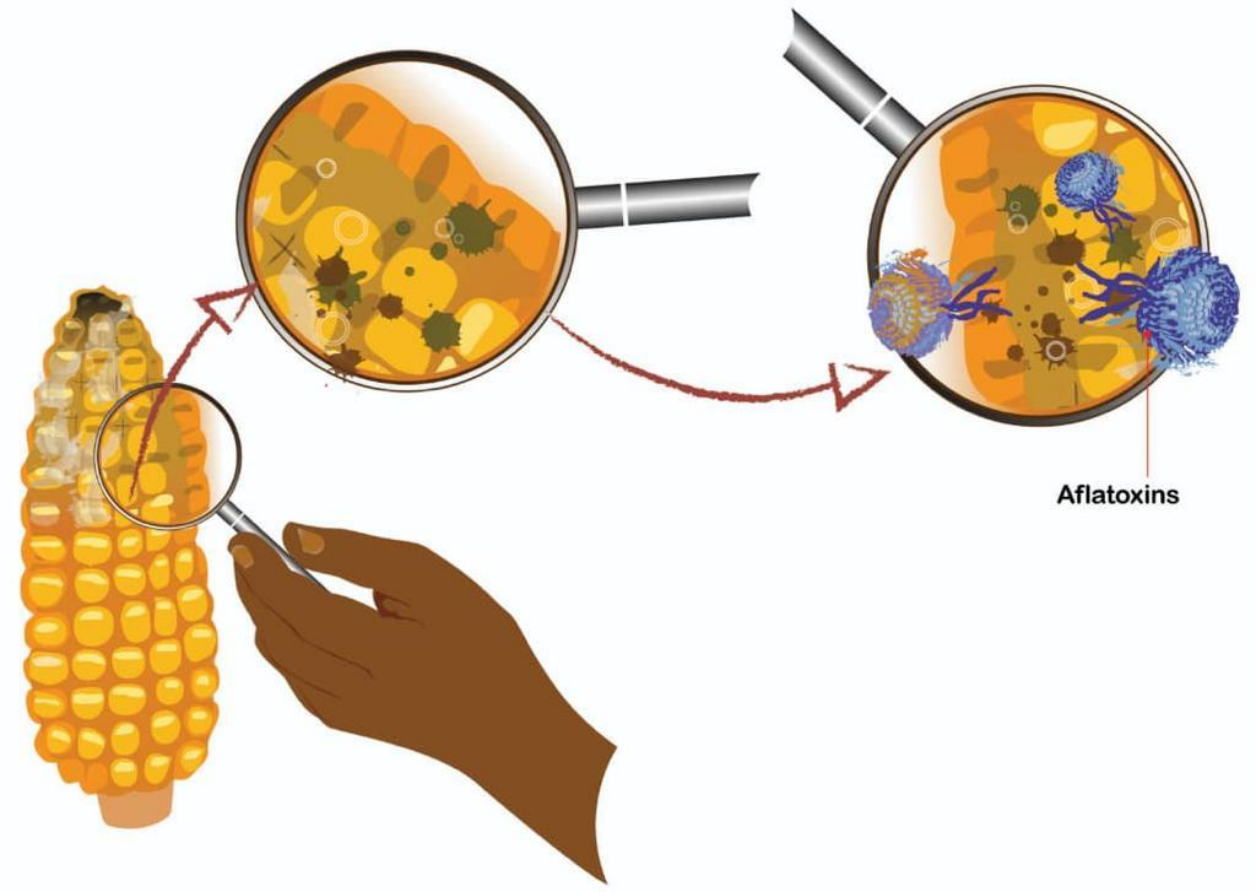

***Figure 46**: Maize contaminated with aflatoxins.*

Factors that increase the risk of aflatoxins.

- Fungal growth and aflatoxin contamination are the consequences of interactions among the fungus, the host and the environment.
- The appropriate combination of these factors determines the infestation and colonization of the substrate and the type and amount of aflatoxin produced.
- Water stress, high- temperature stress, and damage (insects, birds, and rats) of the host plant are major determining factors in mould infestation and toxin production.
- Specific crop growth stages, poor nutrient and soil fertility, high crop densities, and weed competition have been associated with increased mould growth and toxin production.

Figure 47 - Groundnuts contaminated with moulds.

Short and long-term effects on health and nutrition

- Consumption of contaminated foods can have serious short and long-term consequences on health and nutrition.
- **Fatal effect:** High levels of aflatoxin ingestion can result in liver failure (acute aflatoxicosis) which is often fatal.
- **Liver cancer:** Consumption of aflatoxins is cumulative. Habitual consumption of contaminated food with aflatoxins at lower levels causes liver cancer.
- **Aflatoxin contamination and stunting:** A growing number of research findings show that high levels of aflatoxin ingestion are strongly associated with stunting and immune suppression in children.

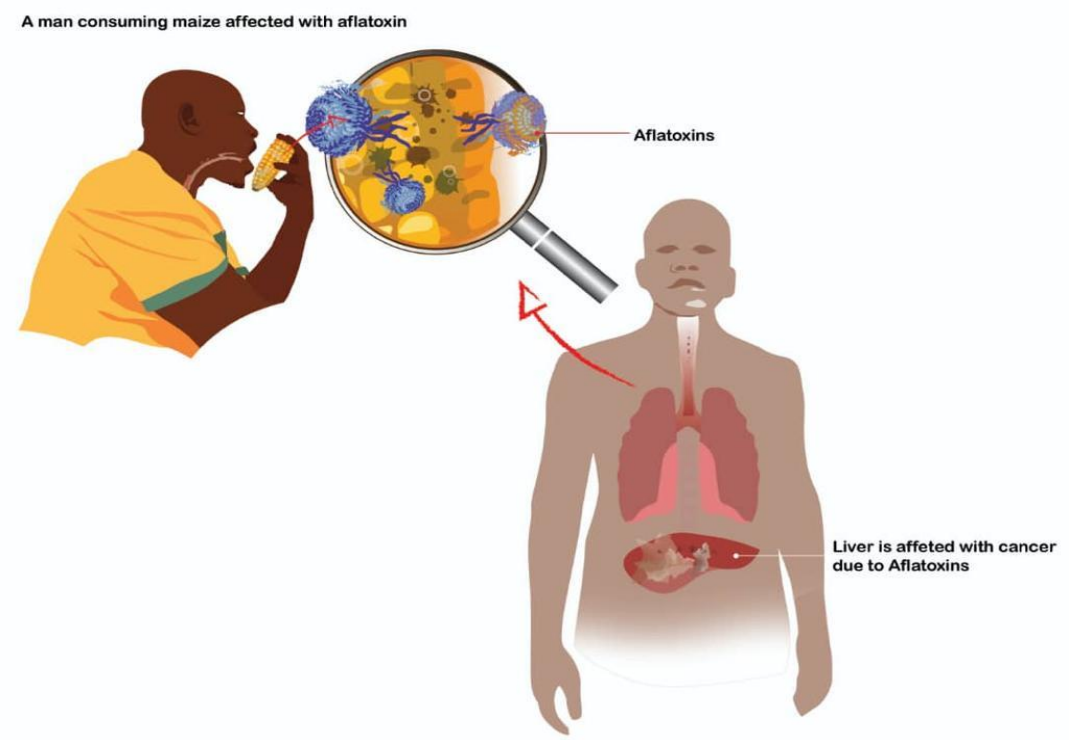

***Figure 48: Effects of consuming food contaminated with aflatoxins*.**

Measures to control aflatoxins.

Post harvest handling of crops.

- Use clean and dry containers for transporting produce from the field to storage.
- Rapidly drying crops to recommended moisture content levels to reduce chances for mould proliferation and aflatoxin contamination.
- Drying unstripped pods on straw using A-frame or stacks with good ventilation or drying stripped pods on clean mats/sacks.
- Remove the damaged grains before storage.
- Avoid sprinkling water on pods and nuts during shelling as this is one of the major conditions that encourage fungal growth.
- Storage facility or equipment must be cleaned of old crop residues and dust.
- Place rat guards and use storage insecticides if necessary.

During processing of crops

- Sort out small, discoloured, and damaged kernels/grains/nuts products.

During storage of crops

- Clean, repair and disinfect the storage structure before bringing in the newly harvested crop.
- Fumigate the storage structure to control insects and rodents with recommended fumigants.

- The storage structure should have a well-built wall and roof to prevent rain seepage and excess moisture.
- The structure should be well ventilated, with low relative humidity.
- Do not mix new produce with old.

Figure 49 - Sorting groundnuts to remove the damaged grains.

Figure 50 - Sorting orange maize by removing damaged or spoilt grains.

Figure 51 - Don't add water to dry products.

Ways in which aflatoxins could be controlled.

Figure 52 - Early Harvesting as a way of preventing aflatoxins.

Figure 53 – Storage of crops on raised pellets helps to prevent aflatoxins contamination.

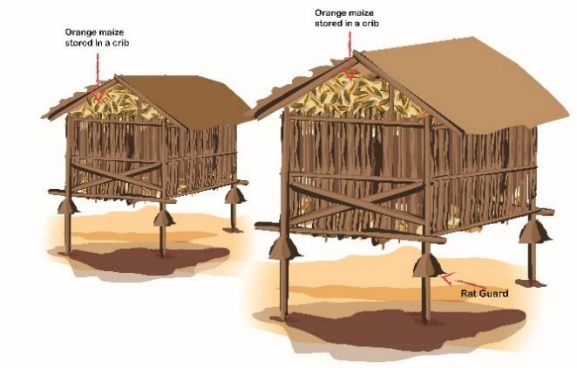

Figure 54 – Storage of orange maize in a raised crib as way of reducing aflatoxin contamination.

STEP 5: SUMMARY (10 MINUTES)

Instructions for the facilitator

- Allow the participants to ask questions for any clarification.
- Ask participants to share the highlight of what they have learnt during the lesson and how they will use it.
- Consolidates and summarizes the main discussion content.

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