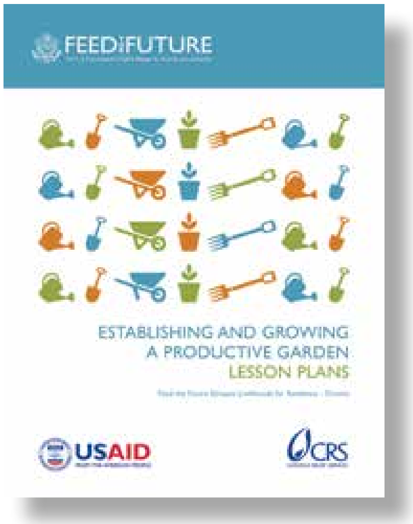
FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

# ESTABLISHING AND GROWING A PRODUCTIVE GARDEN LESSON PLANS

Feed the Future Ethiopia Livelihoods for Resilience - Oromia

USAID FROM THE AMERICAN PEOPLE

CRS CATHOLIC RELIEF SERVICES




Cover design: Solveig Bang

This publication and the associated job aids were made possible thanks to the generous support of the people of the United States of America, through the United States Agency for International Development (USAID). The contents are the responsibility of Catholic Relief Services and do not necessarily reflect the views of USAID or the United States Government.

Authors: Valerie Rhoe Davis and Teklegenet Tamiru
Layout and production: Bang Magnusson
Illustrations by Dawit Tilahun on pages 2, 9, 13-16, 19-21, 22, 26, 35, 37, 40, 44, 58, 63, 67 and 77

CRS
CATHOLIC RELIEF SERVICES

**Catholic Relief Services** is the official international humanitarian agency of the United States Catholic community. CRS' relief and development work is accomplished through programs of emergency response, HIV, health, agriculture, education, microfinance and peacebuilding. CRS eases suffering and provides assistance to people in need in more than 100 countries, without regard to race, religion or nationality.



**Catholic Relief Services**
228 West Lexington Street
Baltimore, MD 21201-3443 USA
1.888.277.7575
crs.org

# ACKNOWLEDGEMENTS

The manual was produced by Catholic Relief Services' Feed the Future Ethiopia Livelihoods for Resilience – Oromia project with the technical support of Valerie Rhoe Davis, Senior Technical Advisor, Agriculture – Gender and Nutrition, and Teklegennet Tamiru, Social Behavior Change Communication Senior Officer, CRS Ethiopia. Tariku Anega translated the content and provided interpretation support during the pilot course.

The project appreciates the support that Meki Catholic Secretariat management and technical experts provided for the initial piloting of the course content: Solomon Kebede, Safayo Ashuta, Tizazu Gudeta, Hassen Mohammed, Wondosen Begashaw, Aferahu Tekle and Bisrat Tesfaye. The contributions of Negash Heda, the Government of Ethiopia Adami Tulu Jido Kombolcha *woreda* agronomist, was much appreciated. The active participation and feedback on the pilot training from the community animators and lead community facilitators of ATJK *woreda* and Dera area were critical in the refining of this manual.

Ian de la Rosa, Chief of Party, Feed the Future Ethiopia Livelihoods for Resilience – Oromia, provided guidance and support in the development of this manual.

# ABOUT THIS MANUAL

This manual is designed to help field-level workers—development agents, community animators and health extension workers—train community members on building and maintaining a homestead garden. This manual is based on content from the CRS Garden Toolkit that consists of a *Garden Resource Guide*, *Project Design Guide* and *Program Manager's Guide*. The seasonal calendar in the manual is adapted from the Sustainable Undernutrition Reduction in Ethiopia (SURE) materials of the government of Ethiopia. Accompanied by job aids, this manual includes eight lesson plans: 1) purpose and benefits of the garden; 2) garden roles and decisions; 3) building a healthy soil; 4) watering the garden; 5) selected garden types (namely raised beds, sunken beds, keyhole gardens and permagardens); 6) planting; 7) protecting your garden from pests and disease; and 8) harvest and postharvest practices.

Each section provides step-by-step guidance that field-level workers should follow to train community members. Each lesson lasts between 45 and 150 minutes with 9 hours being the minimum time required to complete the manual. Completion time may be longer depending on the number of garden types taught and the existing knowledge of community members. It is recommended that lessons should be offered when relevant, and in time for community members to apply the practices.

# CONTENTS

# ACRONYMS

| | |
|---|---|
| ATJK | Adami Tulu Jido Kombolcha |
| CA | community animator |
| CRS | Catholic Relief Services |
| CU2 | children under 2 |
| DA | development agent |
| HEW | health extension worker |
| IYCF | Infant and Young Child Feeding |
| MCS | Meki Catholic Secretariat |
| NSA | nutrition-sensitive agriculture |
| PLW | pregnant and lactating women |
| SURE | Sustainable Undernutrition Reduction in Ethiopia |
| USAID | United States Agency for International Development |

## LESSON PLAN 1

# THE PURPOSE AND BENEFITS OF THE GARDEN

**What**: This lesson plan explains the purpose of the gardens being promoted by the project, supports livelihood group members to understand their level of dietary diversity, and discusses how gardens can support them to improve their dietary diversity.

**Why**: It is important for group members to understand that we are working with them to build and maintain a garden to help improve the access of household members—particularly young children, and pregnant and lactating women (PLW)—to nutritious foods.

**How**: The participants will discuss a series of questions related to dietary diversity and gardens. An optional exercise that highlights gaps in available nutritious foods throughout the year can be used to show to community members gaps in their dietary diversity.

**Adaptation of optional exercise**: The optional exercise is adapted from the seasonal food calendar exercise in the Sustainable Undernutrition Reduction in Ethiopia (SURE) program *Training Manual on Infant and Young Child Feeding (IYCF) and Nutrition Sensitive Agriculture (NSA)*. The adaptations include identifying:

- Foods in the food calendar eaten by children under 2 (CU2) and/or pregnant and lactating women.
- The sources of foods throughout the year.
- When a food is consumed most.

If the development agent or community animator has already conducted this exercise with the group as described in the SURE manual and has the information available, they can review these results with community members and then continue with the adaptations. This would reduce the time needed for this exercise.

**Planning**

- If using the optional exercise, adapt the seasonal food calendar to the local context.
- Print the seasonal food calendar.

**Timing**

- Lesson plan with optional exercise: 2 hours
- Lesson plan with adapted optional exercise: 90 minutes
- Lesson plan without exercise: 45 minutes

**Materials**

- Flip book with drawing of Ethiopian food plate and adapted seasonal calendar
- For exercise, seasonal food calendar worksheet
- Pen/pencil

## Ask

When asking the following questions, seek responses from many of the participants in order to understand the different perspectives among community members. Allow men and women to provide responses without judgement. These questions will help you understand the community members' level of understanding of diverse diets.

**? What is a diverse diet? Why is a diverse diet important?**

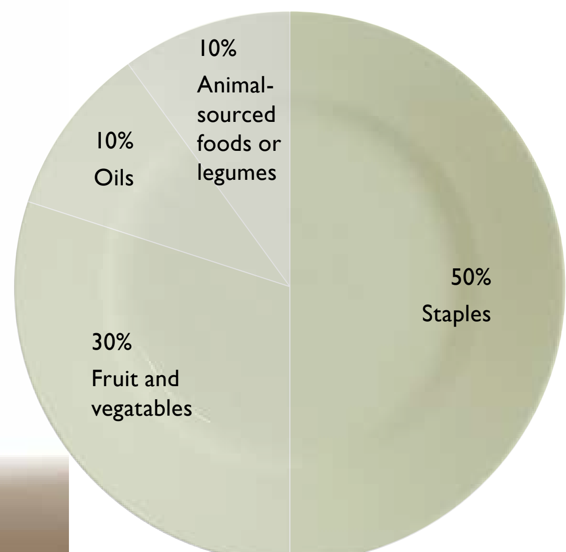
Listen for responses related to a diet that provides a range of nutrients (e.g., proteins, carbohydrates, minerals and vitamins) or a diet made up of different types of foods such as staples (wheat and maize), fruit and vegetables, beans and animal-sourced foods.

## Show and explain

*Remember that since we have been meeting in this group, we have had several sessions on improving nutrition by eating different types of food that provide different nutrients that help make your body strong and healthy.*

**? How much of each type of food should we eat every day?**

Listen for responses such as: About half (50 percent) in staples (maize, wheat), about a third (30 percent) in fruit and vegetables, some fats (cooking oil, avocado) (10 percent); some animal-sourced foods (eggs, milk, meat, fish) or legumes (beans, groundnuts) (10 percent).[1] After listening, show what these proportions look like on a plate using the drawing below to reconfirm the discussion or correct misunderstandings.




1. Sustainable Undernutrition Reduction in Ethiopia (SURE) program. December 2015. *Training Manual on Infant and Young Child Feeding (IYCF) and Nutrition Sensitive Agriculture (NSA).* Federal Democratic Republic of Ethiopia Ministry of Health & Ministry of Agriculture and Natural Resources.

**Are there times of the year when your family does not eat enough fruit, vegetables and beans? If yes, why does your family not consume much of these foods at these times?**

Listen for responses related to insufficient production, the crop not being produced at certain times of the year, unequal allocation of the food within the household, the food item rotting too fast, the food not being available in the market, or other reasons. Take note of these responses so you can address them in upcoming lessons.

**Optional exercise:** In Annex 1, there is an exercise you can do with community members that will help them understand their families' dietary diversity and any gaps in diversity throughout the year. If you do not do the optional exercise, proceed to the next discussion question for community members.

**How can growing a garden at home help improve dietary diversity?**

Listen for responses related to increasing the quantity of nutritious foods such as vegetables, fruit and beans that are available; increasing the availability of diverse, nutritious foods at times when they are not regularly available in the market; increasing women's access to food needed to provide a healthy meal; providing income to buy other diverse foods, etc.

**Is there anything that would limit certain family members from benefiting from more diverse foods being available at home?**

Listen for any issues related to access to and control of produce, decision-making power over how produce is used, cultural beliefs, allocation of food within the household, religious traditions (i.e. fasting). Take note and bring these issues back to the project team to discuss and determine how they can be addressed. If there is a future lesson on a constraint, mention it to the group.

**Are you interested in learning about growing a garden or improving your existing gardens to increase the dietary diversity of your family?**

Thank the livelihood group members for their active participation.

## ANNEX 1: OPTIONAL EXERCISE

# NUTRITIOUS FOODS: WHAT, WHEN AND FROM WHERE?

*We will now do an exercise to better understand which nutritious foods we already eat during the year and how we get this food.*

Identify a community member for each group that can read and write, or the facilitators can help fill in the responses from the group.

**Step 1**: Depending on the cultural context and group dynamics, decide whether to divide the group into two same-sex groups or have one mixed-sex group.

**Step 2**: Using the adapted seasonal food calendar for this exercise, gather information from group members on when the household consumes each food type during the year. For each food, ask when it is eaten and mark the month with an "X". For each food, ask in which month(s) the household eats the most of that food. Write two more "Xs" in the boxes reflecting those months (XXX).

After going through each food, ask if there are foods that they eat that are missing. Add this food to the food calendar and gather information on consumption.

### Examples of a completed seasonal calendar for this exercise

| Food group | Type | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June | July | Aug | CU2 | PLW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Staples** | Maize | X<br>LM | X<br>LM | XXX<br>H | XXX<br>H | XXX<br>H | X<br>H | X<br>H | X<br>H | X<br>H | X<br>LM | X<br>LM | X | X | X |
| | Wheat | X<br>LM | X<br>LM | XXX<br>H | XXX<br>H | XXX<br>H | X<br>H | X<br>H | X<br>H | X<br>H | X<br>LM | X<br>LM | X | X | X |
| **Legumes/ nuts** | Haricot beans | X<br>LM | X<br>LM | XXX<br>H | XXX<br>H | XXX<br>H | XXX<br>H | X<br>H | X<br>H | X<br>H | X<br>LM | X<br>LM | | X | X |
| **Vegetables** | Kale | X<br>H | X<br>LM | X<br>LM | | | | | | | | XXX<br>H | XXX<br>H | X | X |
| | Cabbage | X<br>H | X<br>LM | X<br>LM | X<br>LM | X<br>LM | X<br>LM | X<br>LM | X<br>LM | X<br>LM | X<br>LM | XXX<br>H | XXX<br>H | X | X |
| **Animal-sourced** | Egg | X | X | X | X | X | X | X | X | X | X | X | | | |
| | Milk | | | | | | | | | | | | | | X |

**Step 3**: Ask: *Which foods from the list do children under 2 years of age eat?* Place an "X" in the CU2 column for each food they consume. If they do not consume a food, leave the space blank. Ask: *Why is the food not consumed?* Take note of any issues that you can address in future sessions.

**Step 4:** Ask: *Which foods from the list do pregnant and lactating women eat?* Place an "X" in the PLW column for each food they consume. If they do not consume a food, leave the space blank. Ask: *Why is the food not consumed?* Take note of any issues that you can address in future sessions.

**Step 5:** For each time of the year food is consumed, identify where the household gets the food by placing the following letter in the correct months:

- H - home production
- N - neighbors
- LM - local market
- RM - regional market

Adjust categories to align with the local context.

**Step 6**: If two groups were formed, bring together the members and ask each to present their calendar. Ask: *What is similar about each calendar? What is different?* Allow participants to discuss the reasoning behind the differences.

**Step 7**: Ask the group: *What do you observe about diverse food being consumed?*

Summarize the findings to link to the purpose of the garden, which is contributing to nutritional outcomes through increased access to diverse, nutrient-rich foods.

After finishing the exercise, return to the lesson plan.

## Seasonal calendar of nutritious foods*

| Food group | Type | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June | July | Aug | CU2 | PLW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Staples** | Teff | | | | | | | | | | | | | | |
| | Barley | | | | | | | | | | | | | | |
| | Millet | | | | | | | | | | | | | | |
| | Sorghum | | | | | | | | | | | | | | |
| | Maize | | | | | | | | | | | | | | |
| | Wheat | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Legumes/ nuts** | Lentils | | | | | | | | | | | | | | |
| | Beans | | | | | | | | | | | | | | |
| | Groundnuts | | | | | | | | | | | | | | |
| | Chickpeas | | | | | | | | | | | | | | |
| | Pigeon pea | | | | | | | | | | | | | | |
| | Haricot bean | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Vegetables** | Kale | | | | | | | | | | | | | | |
| | Pumpkin | | | | | | | | | | | | | | |
| | Cabbage | | | | | | | | | | | | | | |
| | Broccoli | | | | | | | | | | | | | | |
| | Squash | | | | | | | | | | | | | | |
| | Lettuce | | | | | | | | | | | | | | |
| | Tomatoes | | | | | | | | | | | | | | |
| | Onions | | | | | | | | | | | | | | |
| | Garlic | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Animal-sourced foods** | Egg | | | | | | | | | | | | | | |
| | Milk | | | | | | | | | | | | | | |
| | Meat | | | | | | | | | | | | | | |
| | Fish | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

| Food group | Type | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June | July | Aug | CU2 | PLW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fruit** | Bananas | | | | | | | | | | | | | | |
| | Mangoes | | | | | | | | | | | | | | |
| | Oranges | | | | | | | | | | | | | | |
| | Papaya | | | | | | | | | | | | | | |
| | Guavas | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Oils** | Cooking oil | | | | | | | | | | | | | | |
| | Avocado | | | | | | | | | | | | | | |
| | Oilseeds | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Roots/ tubers** | Irish potato | | | | | | | | | | | | | | |
| | Beetroot | | | | | | | | | | | | | | |
| | Orange-fleshed sweet potato | | | | | | | | | | | | | | |
| | Carrots | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

Source: Sustainable Undernutrition Reduction in Ethiopia (SURE) program. December 2015. *Training Manual on Infant and Young Child Feeding (IYCF) and Nutrition Sensitive Agriculture (NSA).* Federal Democratic Republic of Ethiopia Ministry of Health & Ministry of Agriculture and Natural Resources.

* Adaptations to the seasonal calendar: In addition to months, identify how to adapt the calendar based on how beneficiaries understand the different time periods of the year (rainy season, holiday, etc).

**Note**: Please use the blank rows to add foods missing from this table.

LESSON PLAN 2

# GARDEN ROLES AND DECISIONS

**What**: This lesson will help you and the members of the group understand who within the household will be working on the garden and making decisions related to the garden and its outputs.

**Why**: Women are commonly responsible for gardening, but we should not assume that it is always their domain. Even if women do most of the garden work, they may not have full control over the decisions about the garden and its outputs. Given the potential workload of a garden, there is an opportunity to discuss how different household members can work together on the garden and other responsibilities to ensure an equitable work balance.

**How**: Using pictures, the DA/CA will support community members in identifying who does what in a garden and who makes decisions about these tasks.

| | |
|---|---|
| **Planning**: Adapt photos of garden tasks to reflect cultural context | **Materials**: Flip book with photos of different roles and responsibilities |
| **Timing**: 45-50 minutes | |

## Ask

When asking the following question, seek responses from many participants in order to understand the different perspectives among community members. Allow men and women to provide responses without judgement. This question will help you understand who within the household is primarily responsible for the garden(s).

**? If you have a garden, who within the household takes care of it?**

Listen for responses related to who builds the garden, who maintains the garden and who makes decisions about the garden and the produce that comes from the garden.

After asking this question and encouraging discussion, move to the next section.

## Show and explain

### EXERCISE

*Building, maintaining and benefiting from a garden can take time and requires inputs and labor in order to be successful. Although we briefly discussed who takes care of the garden, let's look at the major roles within gardening and understand who will be doing that work and how family members can support each other while the main fields are being planted, maintained and harvested. Decisions about how the garden is managed and the use of its produce will also affect the amount of nutritious food available for the family to eat.*

*We will look at a few pictures that represent key roles and responsibilities, and discuss who takes each role and who makes decisions related to each role/responsibility. Under each picture of the role, specify who is mostly responsible for that role: men, women, girls or boys. If more than one group is responsible for the role, confirm who does most of the work. If there is an equal amount of work done, then include both groups.*

The DA/CA captures group members' responses under each picture.

Building the garden; purchasing and managing tools, seeds, etc; maintaining the garden (planting, watering, weeding, monitoring pest/ diseases, harvesting); cooking/ preservation/processing; marketing; income.

If group members have participated in the Strengthening Marriages and Relationships through Planning and Communications (SMART) Couples training and/ or Community Conversations, let group members know that this lesson enables them to apply what they learned to support equitable workloads and benefit from the garden.

Determine whether this discussion can happen in a mixed-sex group or if two parallel discussions with same-sex groups are needed. If two separate same-sex groups are formed, then each group needs to present its responses, and the differences between the two groups should be discussed.

**What do you observe about who is working in the garden and who is making decisions about the garden?**

Listen for responses around the unequal workload of a particular family member or equal workload across the family, how working on a garden may redirect labor within the family, how family members can support each other with this work, disconnects between those who work in the garden and those who make decisions about the garden outputs, and those who make decisions about tools and inputs and those who need to use the tools and inputs.

**What actions can you take to ensure family members:**

- **Share the workload of the garden?**
- **Have access to the resources they need to grow a successful garden?**
- **Benefit equitably from their efforts in the garden?**

When discussing sharing workload, ensure the discussion does not entail girls and boys missing school to support the garden.

**As we will be gardening at the same time as planting and maintaining the main fields, does this effect how we plan our work and/or have access to resources for the garden?**
**If so, what can you do to address these concerns?**

Listen for ideas about building the garden before the rains come, planning to have resources available for both the main fields and the gardens, understanding that time may be needed to harvest the vegetables at the same time key support is needed in the main fields, and decisions needing to be made to ensure garden crops are harvested at the right time.

**What might stop you from trying these practices?**

Listen for any technical support or coordination efforts the project can provide. Listen for any gender issues related to access to and control over resources, workload and decision-making power over using practices.

Thank the group members for their active participation.

LESSON PLAN 3

# BUILDING HEALTHY SOIL

**What**: This lesson plan will share four simple do-it-yourself tests to better understand the soil that will be used for the garden and provide information on several practices to improve soil health.

**Why**: Garden soils are different across plots of land. It is rare that a garden has no soil problems. Understanding the soil health and how to improve soil quality will help gardeners improve productivity as well as enable them to monitor changes in soil health as they amend their soil.

**How**: Practice four soil tests with community members and briefly explain practices for improving soil health. A tip sheet to train on specific soil amendment practices is available if additional training is needed.

### Planning

- If video equipment is available, show the videos below. Ensure you have a way for community members to hear sound.
- Recommend practicing the tests before teaching them.
- Gather information on what soil practices community members are using. If a soil practice is not being used, adapt the lesson plan to incorporate information and the exercise from the tip sheet.

### Materials

Soil tests: Spades, light-colored cloth/paper or bucket, water, ruler, marking stake/sticks, pencil, watch/timer on phone.

Soil amendment practices: If you have identified that there are practices not being used, determine what materials you will need by reading the tip sheet.

**Timing**: 45-50 minutes without showing how to do the soil amendment practices

### Videos

- Topsoil depth test, earthworm test
- Soil drainage test
- Squeeze-and-feel test
- Compost

## Ask

When asking the following questions, seek responses from many participants to understand the different perspectives. Allow men and women to provide responses without judgement. These questions will help you understand community members' current level of understanding about soil quality and how they know the quality of their soil.

?

- **Can you describe the quality of the soil where you are likely to grow your gardens?**
- **How do you know this is the quality of the soil?**

Listen for things such as: my soil drains fast or slow, it forms or does not form a ball, it has a lot of live insects in it, it does not produce a lot, it is sandy, it is hard/feels like clay, it crumbles easily, etc.

## Show and explain

*Remember there are four types of soil: sand, clay, silt and loam. The ideal soil for gardening is loam (40 percent sand, 40 percent silt and 20 percent clay). If you don't have loam soil, it doesn't mean you can't plant a garden, but it reminds you that you will need to improve your garden's soil health. Understanding the type of soil you have will give you a good idea of how well it drains water, holds water in dry spells and whether it will be more or less fertile.*

*Today we will be practicing four easy soil tests to help us better understand our soil:*

1. *Topsoil depth*
2. *Soil drainage*
3. *Live organisms*
4. *Squeeze and feel*

*We will also discuss a few key practices to help improve the quality of the soil to be used in our gardens.*

Before going the demonstration site, show all videos related to soil testing

- Home Soil Test - No Equipment Needed. Smilinggardener.com (topsoil depth and live organism test)
- Soil Percolation (perc) Test. Horticultureguy.com. (Soil drainage test)
- Work out your Soil Type with the 'Squeeze Technique'. HuwsNursery (Squeeze and feel test)

**EXERCISE**

# SOIL TESTS

### Step 1: Topsoil depth test

Ask for three volunteers to each dig a hole in three different locations. Each hole should be 30 cm (12 in.) wide, 30 cm (12 in.) long, and 30 cm (12 in.) deep. Each participant should place the soil from each hole into a bucket or on light-colored cloth/paper.

Top soil test: Clay, sandy and loam soils (from left)

?

- **When you dug into the soil, was it difficult or easy to dig?**
- **What color is the soil?**

*If it is difficult to dig, comes out in clumps, or is grey, then it is more of a clay soil. If it is easy to dig, and*

- *is light brown, it is more of a sandy soil*
- *is dark brown, and clumps fall apart easier, it is more of a loam soil*

### Step 2: Soil drainage test

*We will now start the soil drainage test. We will use one of the holes to test water drainage. Place a marking stake or straight tree branch into the hole. Fill the hole with water, mark on the stick the top of the water line. Use a watch or a timer on your phone to track time.*

1. **Ideal drainage**: *2.5-5 cm (1-2 in.) per hour*
2. **Rapid drainage**: *More than 5 cm (2 in.) per hour*
3. **Poor drainage**: *Less than 2.5 cm (1 in.) per hour*

As the water drains, ask the following questions:

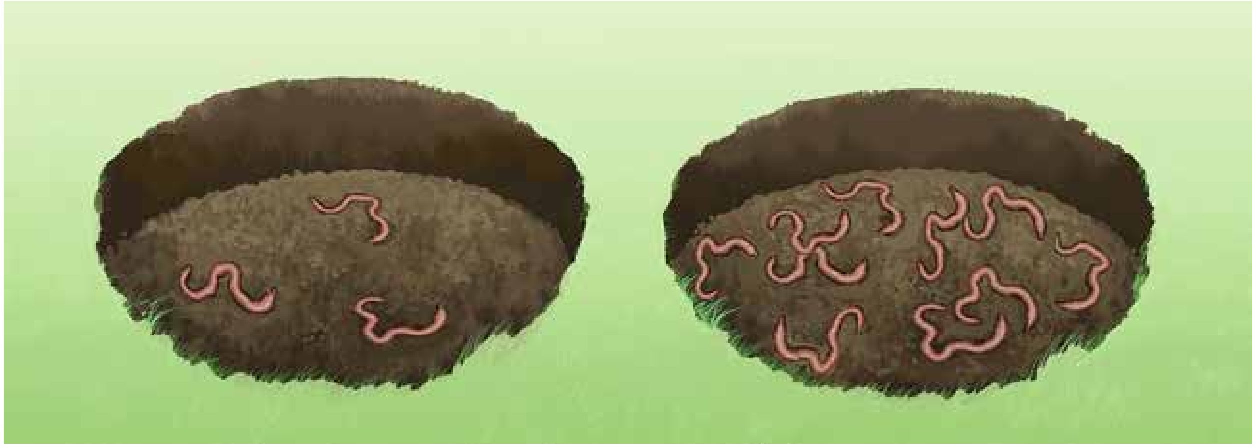
**? What does it mean if the water drains too fast?**

Listen for responses such as that the soil contains a lot of sand, does not hold water between rainfalls, or is poor in nutrients as they are washed away with the rain. If these responses are not shared, mention them.

**? What does it mean if the water drains too slowly, puddles or turns to mud?**

Listen for responses such as the soil is likely to be made of silt or clay; it holds water but lacks air space; it may be hard to work; or it can be rich in nutrients, but the plants cannot access the nutrients. If these responses are not shared, mention them.

### Step 3: Live organism test



*As it should take some time for the water to drain, let's do the live organism test. A healthy soil has many small, visible insects and animals, such as earthworms and termites, living and working beneath the surface. The more living animals it has, the healthier the soil.*

*Let's look at the soil in each of the three piles of dirt that we dug up. Count the number of earthworms, termites and insects in each pile.*

**? How many live earthworms, termites and insects did we find in each pile of dirt?**

*Let's now take an average: Add together the total number of live earthworms, termites and insects from each pile and divide by three. What is the answer?*

Help participants to interpret the results using the table below.

#### Interpreting the live organisms test

| Average | Soil health |
|---|---|
| 10 or more | Very healthy soil |
| 6 to 9 | Fairly healthy soil |
| 5 or less | Possible problem soil: very acid or alkaline, little organic matter, heavy soil (poor drainage), over application of chemicals, over-tilled. |

### Step 4: Squeeze-and-feel test

*We will now do the squeeze-and-feel test.* Have participants combine equal amounts of the soil from all three holes into one pile (in a bucket or on cloth/paper). Mix the dirt up well, break up clumps of dirt, and remove any roots and rocks.

Have each participant take a handful of moist dirt (not wet). If needed, add water to the soil in the hand. Firmly squeeze the moist dirt and open your hand.

**When you squeeze the ball in your hand and open it, what does it do or feel like?**

*If the soil does not form anything like a ball, it is sand.*

- *If it feels gritty, it has a lot of sand or gravel.*
- *If it is difficult to see the particles easily, it is sandy.*
- *If there are small pebbles, it is gravelly.*
- *If the soil formed a ball, then poke it. If it crumbles (comes apart), it is a loam soil. If soil remains in a ball and*
  - *it holds its shape and feels sticky, it has a good amount of clay.*
  - *the ball can roll into a fat snake, it has too much clay.*
- *If it feels soapy, slimy or greasy, it contains silt.*

### Let's check the results of the drainage test

*Let's go back to the hole that we put the water into to test the soil's drainage. Stop the timer on the watch or phone and record how much time has passed. Using a pencil, mark on the measuring stake where the water is at this time. Using a ruler, measure the difference on the measuring stake. How much water drained over how much time?*

Remember, information on the rate of drainage and quality of soil is mentioned above.

Ask the following questions to understand whether participants see the benefits of these tests and whether they face complications or barriers to practicing these tests in their gardens.

- **What did you learn about the soil you tested today?**
- **Why is this important?**
- **What may limit your ability to use these tests on your garden area?**

This component of the lesson plan is set up with an assumption that community members have received natural resource management training already. If community members need more information, a tip sheet in Annex 2 provides instructions on each of the practices mentioned below.

*If the soil tests showed that your soil was not healthy, there are four practices you can use to improve the soil in our gardens:*

1. *Composting*
2. *Mulching*
3. *Spreading rotten animal manure*
4. *Crop rotation*

- **Which of these practices do you already use? Why do you use these practices?**
- **For practices not being used, why are they not being practiced?**

Listen carefully to responses to identify ideas/issues that the DA/CA can act on to help with the adoption of these practices in gardens.

**What soil tests and practices do you agree to try in your garden? What might stop you from trying these practices?**

Listen for any technical support or coordination efforts the project can provide. Listen for any gender issues related to access to and control over resources, workload and decision-making power over using practices.

There is a form in Annex 3 to record results of the soil test at the next meeting.

Thank the group members for their active participation.

ANNEX 2

# TIP SHEET

## COMPOST

Ask the questions below to get an understanding of what the participants already know about composting.

?

- **Who has produced compost before?**
- **What did you do to produce compost?**

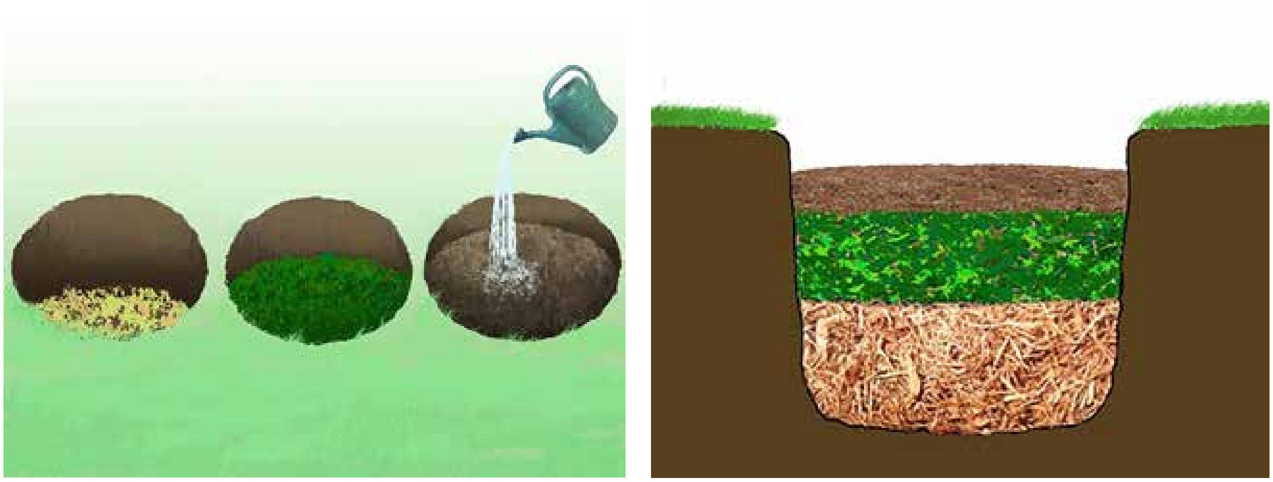
*Compost is a blend of organic materials mixed together and allowed to decompose into rich, dark humus sometimes called "gardener's gold." To help us think about the different ingredients in compost, let's divide them into the "greens" that tend to be rich in nitrogen and the "browns" that have lots of carbon.*

- **"Browns" (high in carbon)**: Dried leaves, grass, straw, dead plants, crop residue (maize, wheat).
- **"Greens" (high in nitrogen)**: Vegetable peelings; fruit skins; the leaves and pods of beans and peas; coffee grounds; leaves from leguminous trees (e.g. *Gliricidia* or mother of cacao, *Acacia, Leucaena)* or green manure crops, e.g. jack bean *(Canavalia)*, velvet bean *(Mucuna),* nyama *(Piliostigma reticulatum),* sunhemp *(Crotolaria ochroleuca)* and lablab bean *(Dolichos lablab);* hair or animal fur; animal manure from animals that do not eat meat (e.g. poultry, cows, horses, sheep, goats and rabbits). ***It is not advisable to use eucalyptus leaves in compost as the can be poisonous if not properly decomposed.***

- Not all "greens" (nitrogen-rich plants) are green in color.
- If soil is acidic, add ash and eggshells crushed into small pieces.
- To help keep rats and animals away from the compost, do not add meat, bones, dairy products (milk, cheese, yogurt, cream, butter) or anything with fat or oil.

EXERCISE

## PRODUCING COMPOST



Steps for making compost: Lay coarse brown materials at the bottom, add a layer of green, then a thin layer of soil, and then water.

- Video: *Black Gold: The Secrets of Compost, Garden Africa*

- Identify a site near the kitchen or garden, but at least 10 meters from a water source.
- In arid areas, dig a 1 meter x 1 meter hole.
- Lay at least 5 cm (2 in.) of dry, coarse browns at the bottom of the hole.
- Add a layer of greens 2-3 cm (1 in.) deep. This will vary based on the types of greens and browns you are using because different soils and plant types contain different amounts of nutrients. Gardeners can experiment to find what works best in their garden.
- Add a thin layer of soil.
- Apply enough water to dampen the layers. The soil should be moist, not drenched.
- Repeat these layers as more greens and browns are collected.
- Every three to four days, use a shovel or garden fork to turn the pile. Move the center of the pile to the edges and the edges of the pile to the center. Turning regularly will help reduce any bad smell. Turning every day will speed up the composting process.
- Keep the soil slightly wet.
- When the center of the pile becomes dark and crumbly, and smells sweet, it is ready to use.
- When there is enough compost to add to the garden, transfer it. Leave the part of the pile that is not fully decomposed to start the process again for a second round of compost.
- If animals such as dogs or goats roam free, they may dig into the pile and gardeners will need to fence it off with thorny bushes or by other means.

**One part greens to two parts browns**

## Notes of caution

1. Ash from wood fire is very alkaline and improves acidic soils. Add only very small amounts to the compost pile and monitor changes in the garden before adding more. Too much ash will slow or stop the activity of soil microorganisms.
2. Handling manure: Do not touch manure with your bare hands. Wash your hands and clothing after applying manure as germs from the soil and animal manure can cause illness.
3. If compost smells bad:
   - There may be too much water and too little air flow. Dig and turn the pile over. Move new material from the edges to the center of the pile and move the center to the edges.
   - If there is too much "green" or nitrogen (fresh kitchen peelings or manure), the pile will need more "brown" (dead leaves or other browns).
4. If the pile decomposes slowly, there is not enough nitrogen for microorganism populations to increase and do the decomposing work, so add more "green."

## MULCH

Fresh or dead plant matter: leaves, stems and straw are placed on top of the soil to decompose.

- Gather fresh or dead plant matter: leaves, stems, straw, rice hulls, maize husks and sorghum stalks.
- Place it on top of the soil to decompose.
- Earthworms feed on mulch and incorporate the organic matter into the soil where microorganisms transform it into plant nutrients.

## ROTTED (OLD) ANIMAL MANURE

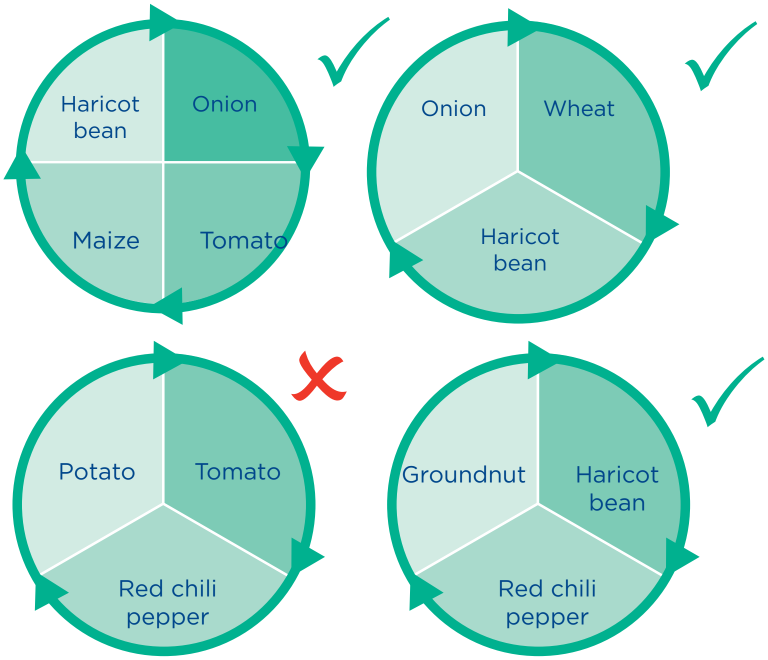
Animal manure mixed with straw in a hole.

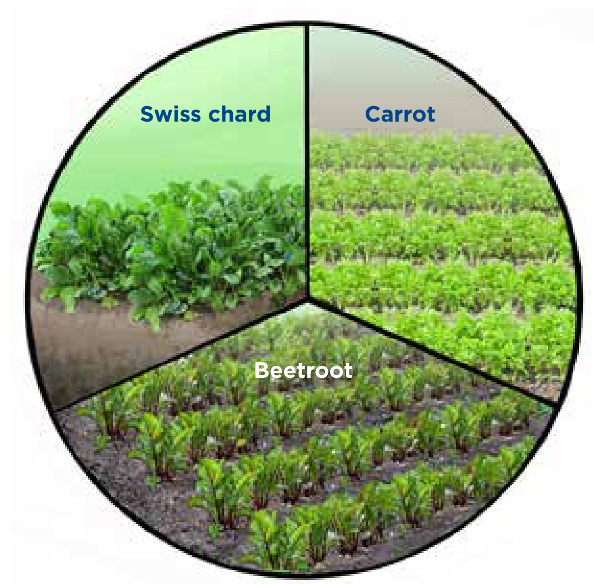
- Mix animal manure with straw in a hole.
- Let sit for one to two months; it has rotted when it no longer smells bad, but smells fresh.
- Once manure is fully composted, mix it into the top layer of soil. Remember that rotted manure should be added two weeks before planting to ensure food safety.

> Fresh animal manure is so strong that it will burn plants, so it needs to be aged ("cured") first.

## CROP ROTATION

- Most root crops and herbs are light users of soil nutrients, but cabbage, tomatoes and maize are heavy users of nitrogen and phosphorus.
- Nitrogen-loving plants (the users) can be preceded or followed by legumes (beans, groundnuts, etc.) or green manure (the producers). Both legumes and green manure add nitrogen to the soil. See the table below on crop rotation guidelines.




Planting vegetables in a new spot in the garden each season reduces damage from disease and pests, and keeps the garden fertile.

### Crop rotation guidelines

| Plant group | Crop rotation |
|---|---|
| **Onions, garlic** | Rotate with legumes (producers). Avoid planting with undecomposed organic matter. |
| **Carrots, parsley, coriander (cilantro), parsnip** | Add compost to soil before planting. These moderate feeders can come after any other plant group. Follow with legumes. |
| **Cabbage, radish, broccoli, leafy vegetables** | Plant legumes the season before. These vegetables are heavy users, so apply compost or aged manure to the soil before planting. |
| **Melons, squash, pumpkin, cucumber** | Follow with legumes or plant green manure between the vegetable rows. |
| **Beans, peas, cowpeas, pigeon peas, green manure** | Alternate these producers with all other garden crops where possible. |
| **Maize, millet, sorghum** | Plant grains before tomatoes, melon and squash to control weeds and retain water. |

ANNEX 3 (OPTIONAL)

# FIELD AGENT FORM: TEST RESULTS BY GARDENER

(Collect information during a group meeting)

| Name | Topsoil depth test | Drainage test | Live organism test | Squeeze-and-feel test |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

LESSON PLAN 4

# WATERING THE GARDEN

**What**: This lesson reviews the importance of proper watering of gardens, shares broad guidance on proper watering techniques, and offers options for limited watering in the dry season (hand watering, clay pot irrigation).

**Why**: Water is required and essential to a garden's productivity, but access to water is a common barrier. With climate change significantly impacting water resources spatially (where rain falls) and temporally (when rain falls), gardeners need to adapt to these changing rainfall patterns to ensure water is available and accessible for their gardens.

**How**: This session includes a number of discussions, information to share and an exercise.

| Planning | Materials |
| --- | --- |
| ■ Gather information on the water needs of the garden crops being promoted.<br>■ If demonstrating clay pot irrigation, buy or find a porous unglazed clay pot.<br>■ If video equipment is available, show the video. Ensure you have a way for community members to hear sound. | **Materials**: Porous, unglazed clay pot; spade/shovel; water |
| **Timing**: 45 minutes | **Video**: Clay pot irrigation |

## Ask

When asking the following questions, seek responses from many participants to understand the different perspectives among community members. Allow men and women to provide responses without judgement. These questions will help you understand the community members' knowledge of the importance of water to gardens.

**? Why is the correct amount of water important for vegetable gardens?**

Listen carefully for responses on the benefits of adequate water, such as healthy plants that produce the expected amounts of vegetables or fruit. Also listen for the disadvantages of too little or too much water. Too little can result in wilting and lower production of vegetables or fruit, while too much can cause stunting and rot the root resulting in no new growth.

After asking these questions and encouraging discussion, move to the next section.

## Show and explain

*Building, maintaining and benefiting from a garden requires consistent water, either from rain or through human-made approaches, for most nutritious foods. The weather, type of soil and crop, will affect how often you water and how much water you use each time. As you are in an arid region and growing your garden during the rainy season with a temperature ranging from 20˚C to 30˚C, plants will need 6 cm to 9 cm (2.5 to 3.5 in.) of water per week. When it is cooler, plants need about 6 cm and when it is very hot, about 9 cm of water.*

**? How would you identify whether your vegetables have enough water?**

After listening carefully to how the community members know whether their plants are getting enough water, you can share a few ideas that they may not have mentioned:

- *Identify a trigger plant—a plant that is first to wilt when it starts to get dry.*
- *Feel the soil with your hand before you water; if it is still wet to the touch, the plant has enough water. If it is dry, it is time to water again.*

*Your gardens will be growing during the rainy season, which will help ensure there is adequate water, but if there are a few days when no rain falls, you will need to water the garden crops.*

**? What are the potential water sources you can use for gardening when it is not raining?**
**Is anything stopping from you using this water for your gardens?**

Listen carefully to learn about local water sources, such as streams, rivers and small wells that are close enough to the garden, or practices used to collect rainwater.

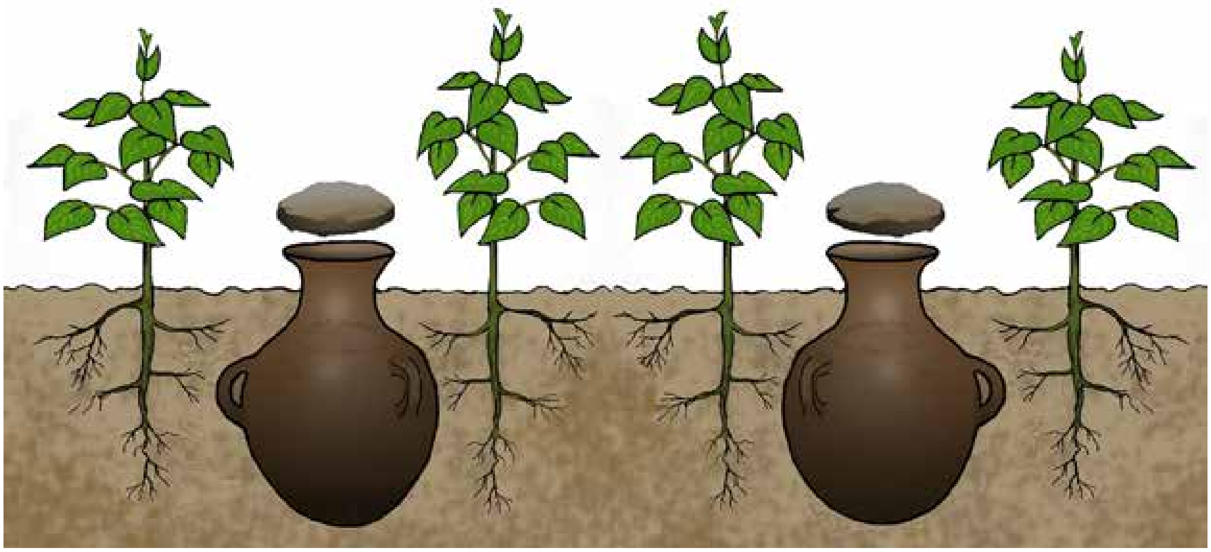
**? If you have to water your garden during the rainy season or into the dry season, what are some best practices for hand watering?**

Listen carefully for the following responses. Briefly introduce the practices below that are not mentioned.

- Water in the morning.
- From a water-filled container/bucket, gently pour the water at the base of the crops through a sprinkler head or by placing your fingers over the container's opening to slow the water flow.
- If the water puddles, leave this plant and water others. Finish watering the plant a little later.
- To reduce the chance of disease, do not wet the leaves as many diseases need moisture. If you must wet the leaves, water in the morning so they have time to dry.
- Apply 5 cm to 7.5 cm (2 to 3 in.) of mulch to help keep the water in the soil and to cool the plant roots. Without mulch, you will need to water more often.
- To avoid creating mosquito breeding grounds, do not let water pool.

**Show the clay pot diagram below. Have you used clay pots or similar materials to help irrigate crops? If yes, please share your experience with us.**

## CLAY POT IRRIGATION



Irrigation using a porous clay pot buried in the soil.

- Show video: *Buried terracotta pot irrigation. Green Urban Living.*

*Clay pot irrigation uses locally made unglazed, porous clay pots that are about 25cm (10 inches) in diameter. The clay pot is buried into the ground and then filled with water. The clay pot allows water to slowly seep through its pores close to the plant roots. Research has shown it can reduce watering needs by up to 50%.*

There are four steps to clay pot irrigation. Show the steps below in a garden area as an illustration.

**Step 1**: Before planting, bury the pot in the soil with the opening just slightly above the soil. Ensure that the clay pot is covered in soil up to its rim.

**Step 2**: Fill the pot with water or greywater. Do not let the greywater touch the edible parts of the plant.

**Step 3**: Cover the pot with a lid to prevent evaporation. The lid also stops soil or small animals falling into the pot, animals drinking from the pot, and mosquitos breeding in the water. Do not use a wooden lid as it will degrade quickly.

**Step 4**: Use a stick to monitor how fast the water is draining. When the pot is half-empty, fill it back up with water. The water from a 25 cm wide (10 in.) clay pot will have a reach of about 45 cm (18 in.) from the pot.

*If we choose to build a raised-bed garden at the demonstration site we will include clay pot irrigation in the construction of our gardens.*

**What actions will you take this garden season to ensure your garden is consistently watered?**

Listen for any technical support or coordination efforts the project can provide. Listen for any gender issues related to access to and control over resources, workload and decision-making power over using practices.

Thank the community members for their active participation.

LESSON PLAN 5 (PARTS A AND B)

# SELECTED GARDEN TYPES

**What**: This lesson plan shares guidance on how to determine where to build a garden(s), and information on four garden types that you can offer to livelihood groups. This plan has two parts. Part A focuses on the benefits and challenges of each garden type so the community group can decide which type of garden(s) to learn about. Part B is the garden-building exercise.

**Why**: There are many types of garden. The type selected depends on the availability and quality of land; the water, labor and material resources available; and the crops to be grown. Selecting the right type of garden will enable the best use of available resources and will support increased production.

**How**: After reviewing the benefits and constraints of each garden, the community group will decide which types of gardens to learn about. This session can happen at the end of Lesson 4. Part B provides guidance on how to determine a good location on a homestead for establishing the garden(s) and then the community members will work together to build demonstration garden(s).

### Planning

This lesson plan is broken into two parts:

- **Part 1** works with the community groups to decide which types of garden to demonstrate and how supplies for building the gardens will be collected for the demonstrations.
- **Part 2** focuses on building the gardens at a demonstration site. Determine whether you will introduce Part A at the end of Session 4 or if you will hold a separate meeting.

During Part B, the CA/DA will only teach the lessons on the specific garden(s) selected by each community.

- Arrange for a location where the gardens can be created by the participants.
- Visit the demonstration site before teaching the lesson to understand where there are sun and shade lines throughout the day.
- Arrange for the equipment and materials to be on the site before the training begins.

If available, arrange for equipment to show the suggested videos. If not available, step-by-step instructions on how to construct each type of garden and illustrations are provided.

### Materials

Flipbook with drawings of the different gardens and steps to building the gardens.

If using clay-pot irrigation, collect at least two 5-liter (25 cm round) clay pots with covers. For crops with a high water demand, use larger clay pots to irrigate them.

**Raised bed**: Rectangular item (i.e. sheet of A4 paper), spade, rake, organic matter (leaves, grass, compost (plants/manure), 4 sticks, digging fork for double digging, 3 sticks to form a triangle ($\Delta$).

**Sunken-bed garden**: Spade, organic matter (leaves, grass, compost (plants/manure), 4 sticks, digging fork for double digging.

**Keyhole garden**: Spade/hoe; mud blocks (medium to large, but nothing smaller than a fist); straw (teff, barley, sorghum); small tree branches; 4 wheelbarrows of manure, 2 wheelbarrows of wood ash, 8 wheelbarrows of soil; 10 meters (33 feet) of string or rope.

**Permagarden**: Rectangular item (i.e sheet of A4 paper), spade, rake, organic matter (leaves, grass, compost (plants/manure), string, 4 sticks, shovel, digging fork for double digging. Triangle for triangle planting.

| Timing | Video |
|---|---|
| ■ Part A: About 30 minutes for the introduction of the session.<br>■ Part B: 15 minutes to determine the location of the garden, and 2 to 3 hours to build each type of garden. | ■ *Double Digging.* Nicholas Heyming.<br>■ *Double Digging.* Peace Corps Senegal.<br>■ *Biointensive planting - The triangle method*. Smilinggardener.com<br>■ *Keyhole garden*. CRS |

## PART A

### Ask

When asking the following questions, seek responses from many participants to understand the different perspectives among community members. Allow men and women to provide responses without judgement. These questions will provide insights into who may already be adopting the behavior of growing and maintaining a garden and why, and why others are not yet growing a garden.

?

- **For those who have a garden, why did you decide to garden?**
- **For those who do not have a garden, why do you not garden?**

Listen closely to the responses. If there are challenges or constraints highlighted that you could address through specific training and/or support, take note of them to explore how to address them in upcoming sessions.

### Show and explain

*There are many types of garden. The type selected depends on the availability and quality of land; the water, labor and material resources available; and the crops to be grown. Selecting the right type of garden will enable the best use of available resources and will support increased production. To decide on what type of gardens we want to learn about, we will look at each type of garden and then take a vote on what type(s) of garden we will be building the next time we meet. We will also decide how to gather the materials to build the demonstration gardens together.*

Top left: Raised beds. *Photo by CRS staff.* Top right: Sunken bed. *Photo courtesy of [Terrie Schweitzer](), licenced under* [CC BY-NC-SA 2.0](). Bottom left: Keyhole gardens. *Photo by CRS staff.* Bottom right: Permagarden. *Photo by Thomas Cole.*

Show the illustration of each type of garden when describing it using the table below.

## Types of gardens

| Type | Land size | Climate/ location/use | Labor requirements | Water resources | Suitable crops | Materials (besides basic tools) | Advantages | Constraints |
|---|---|---|---|---|---|---|---|---|
| **Raised bed** | Small/ medium | Moist climates or during the rainy season. | Medium effort required to construct the garden. Easy to maintain. Weeds are minimal. | Good drainage, but may need frequent watering in the dry season. | Most plants grow well, but shallow-rooted plants are preferred, such as vegetables, herbs and berry bushes. Large vining plants will take up space. Stake/trellis may be used to reduce space needs. | Frames are not required. If using frames, they can be made out of concrete block, bricks, stone, nylon sacks, etc. Wood is not recommended because it rots easily. Tires should not be used as they may be toxic. | Size is determined by gardener to accommodate available labor, space and food needs. | In arid, dry climates, the soil may get too hot and dry out. |
| **Sunken bed** | Small/ medium | Dry areas, dry season, nursery. | Medium effort to establish given double digging. May be more difficult to maintain for those with disabilities or chronic illness as crouching is required. | Designed for moisture retention as it limits water runoff and serves as a water catchment system. Maximizes use of available water found deeper in the soil. | Suitable for all crops, except roots and tubers due to the depth required for optimal growth. | Organic matter/compost. | Supports rebuilding soil health and keeps roots cool in hot climates. | Not suitable for areas prone to flooding or heavy rains, or for soils with poor drainage. Nearby erosion may fill in the bed. |
| **Keyhole** | Small | Semi-arid climates; dry season; location with rocky, difficult-to-cultivate or infertile soils; limited space. | Medium effort to difficult to establish as many materials are required. Easy to maintain. | Designed for moisture retention. Uses greywater. | Suitable for root crops, leafy crops/ greens, carrots, beets, garlic, herbs. Unsuitable for peppers, eggplant, maize and large/ vining plants. | Stones, manure, ash, rotting logs, dry and green grass or leaves, other available organic materials, woven basket. | May be physically appropriate for those with disabilities. | May need to establish multiple keyhole gardens to meet household consumption needs. Some materials may be difficult to access. |
| **Permagarden** | Medium/ large | All seasons, but especially suitable for dry season. | Medium effort to difficult to establish as careful attention must be given to the construction.<br>Medium maintenance effort as it requires close attention. | Designed for moisture retention and flood control. | Suitable for all crops. | Hoes, *pangas*/machetes; 4 watering cans; containers to carry manure, ash, etc.; 4 empty maize seed bags (100 kg); manure, wood ash, charcoal dust; 6–8 jerry cans for water; vessel to hold a bag of manure or chopped leaf material suspended in water; fencing material; nails (1 kg); hammer; twine; bamboo or sticks used to make an A-frame. | Designed to address soil and water constraints. If designed correctly, will optimize use of water and soil nutrients even in the face of drought or other climate shocks. | Uses primarily perennial crops (bushes and trees) and fewer annual crops. The design stage is more intensive than some of the other gardens described. Maintenance will likewise require more time, care and attention from the gardener. |

*Now that we have reviewed the four types of gardens relevant to this area, let's decide what type of gardens we will build during our next meeting.*

Ask each participant to vote on the type of gardens they would like to learn about. Show the drawing of one garden type and ask community members to raise their hand if they are interested in learning more about and building this garden at the demonstration plot during the next meeting. Count the number of people interested. Repeat for each garden type. Based on the votes, determine which garden type(s) to demonstrate at the next group meeting. Participants can vote for more than one type of garden. Remind participants that building the gardens will take time. Identify a time to meet for several hours.

Depending on group dynamics, determine the best way to allow group members to vote for which garden types they want to learn more about.

## PART B

*During our last meeting, we as a group decided to learn how to build and maintain a few types of gardens. Today we will work together to build the gardens as demonstrations.*

### Show and explain

*Before building a garden, identify locations within your homestead to build one or more gardens.*

**What should we consider when deciding where to establish our garden area?**

Listen carefully for the points listed below. If mentioned by the community member, elaborate as appropriate based on what the community member shares and the content below. If a point is not mentioned during the discussion, raise it with the community members at the end of the discussion.

**Sun exposure**: Different plants need different amounts of sun. The gardener may need to identify locations on their homestead that would be suitable for crops with different sun preferences.

- **Full sun (6 to 8 hours)**: Most vegetables, especially fruiting plants—such as peppers, tomatoes and beans—need a minimum of 6 hours to yield well.
- **Partial sun / sun in the morning**: Carrots and beetroot
- **Partial sun**: Lettuce

**Wind**: If the area experiences strong wind, the gardener will need to select a location that includes a natural barrier; otherwise a human-made barrier may be needed.

**Distance from water**: Water is heavy to carry far, so gardening near water is preferred. Also, laying out the garden so it captures rainwater is important.

**Distance from house**: A garden close to the house eases maintenance, allows for easy observation of when water is needed and for the monitoring of pests and disease, and offers ease of access to the food for cooking on a daily basis.

**Size**: Garden size can vary based on household food needs and suitable space to plant vegetables, given the sun exposure, wind, and distance from water and the house. Gardens can be spread throughout the plot to accommodate space issues and sun exposure requirements. Garden beds can be as small as half a meter square. For first-time gardeners, we recommend starting small to get experience.

After hearing from the community members and discussing these key factors, the CA/DA could invite community members to one or two household sites to identify appropriate locations to establish gardens using these factors.

**EXERCISE**

## IDENTIFY WHERE TO ESTABLISH THE GARDEN

At the demonstration site, walk community members through the steps below to help identify an appropriate garden location.

Visit the demonstration site in the late morning (9-10am) and afternoon (3-4pm) before giving this lesson to see where there will be sun for 6 to 8 hours, and shade. After Step 1, let the community members know what you learned from your preparation visits (sun/shade lines on the property).

**Step 1**: Ask: *What parts of the plot have sun and shade now?* Sun and shade will vary on each plot based on what is on or near the property. If there is a tree(s) or a tall building on/near the plot, these will create areas where there is shade. If you are planting maize or other tall crops near the garden area, the tall stalks will provide shade later into the season. The sun and shade will vary throughout the day; identify where there is shade and sun in the morning and afternoon. Note that most vegetables and fruit love sun; there are a few that like shade.

**Step 2**: Ask: *Where is the source of water for the garden?* If on the property, consider placing the garden near the water access point. If not on the property, the gardener needs to consider how to water the garden regularly.

**Step 3**: Ask: *Throughout the whole year, do we need to be concerned about strong wind affecting the garden?* If yes, ask: *Is there a place on the property that would protect the garden naturally from the wind.* If not, then the gardener will need to consider some type of fencing.

**Step 4**: Ask: *Are there areas of the property that livestock or poultry can easily access?* If so, the gardener will need to consider how to keep livestock out of the garden.

**Step 5**: Given sun exposure, water access, wind, livestock, and the house location, ask: *Where are the most appropriate spots to build the gardens?*

**Step 6**: Mark with sticks the corners of the area(s) to be used for gardening. Remember there can be multiple small gardens throughout a plot.

### Protecting our gardens

*Our gardens need protection just like our main fields. We will learn more about protecting our gardens from pests and disease in a future group meeting, but today we will cover just a few points so we are protecting our gardens from the time we build them.*

**What can we do to protect our gardens from disease from the time of first creating them?**

Listen carefully for information on using clean/non-diseased planting material, sanitizing tools and stakes by 1) washing them with clean water and soap, and air drying them; 2) burning metal tools with fire; or 3) using alcohol to disinfect the surface of tools. Discuss any ideas not shared with the community members.

## GARDEN TYPE: RAISED BED

**What**: A raised-bed garden is a flat-topped garden bed created by simply mounding soil and compost/manure into a rectangular shape. The garden can be framed or not.

**Why**: This garden is good in wet climates or during the rainy season. Raised beds provide good water drainage and prevent plants from being damaged by limited flooding from rain. They produce a lot on a limited amount of land when the soil is fertile.

If raised beds are already used in the community by some members, show a photo of a raised bed from a similar community in the project zone or use the drawing in the flipbook. Visit the raised bed if it is in the same village as the training.

**Has anyone built a raised bed? If yes, ask the questions below:**

- *Can you explain what a raised-bed garden is?*
- *What benefits did you get from a raised-bed garden?*
- *What challenges did you face? If you faced a challenge, how did you address it?*

***We are going to build a raised-bed garden without a frame, but you can also build one with a frame made of concrete blocks, bricks, mud blocks, stone or filled nylon bags. The equipment you will need: Spade, rake, organic matter (leaves, grass, compost (plants/manure), string, 4 sticks, digging fork for double digging, 3 sticks for making a triangle.***

Remind participants not to use tires for the frame as they can be toxic.

**EXERCISE**

## BUILDING A RAISED BED

*Note: Given our context, when we build the raised bed garden, we will install unglazed porous clay pots to support irrigation.*

*A raised-bed garden is typically in the shape of a rectangle [show rectangle symbol]. It is 1 meter wide—about the length of a spade/shovel. You should be able to reach from each side of the garden's width to its center without stepping on the bed. If you can't reach the garden's center, it is too wide. The length can vary based on available space, water and labor. To help diversify and stagger planting, you may want to build several separate beds, some in full sun and some in partial shade depending on what crops will be planted.*

Measure the length of the spade/shovel to ensure it is about 1 meter long.

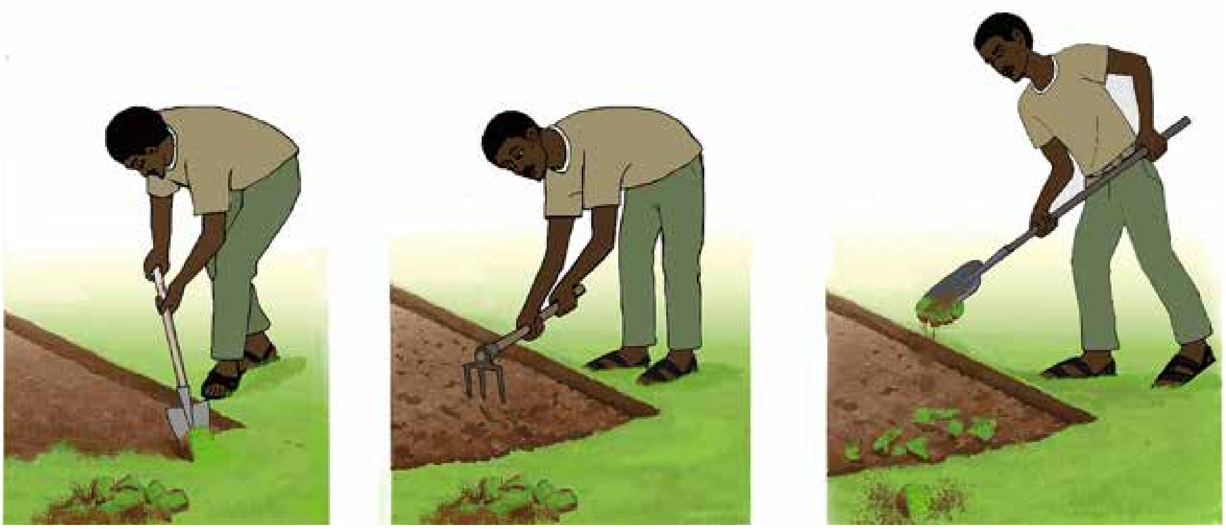
**Step 1**: Use the length of a shovel to measure a plot 1 meter wide by 2 meters long (3.2 x 6.5 feet). Using the four sticks, insert each into the four corners of the garden bed. Remember, the bed should measure 1 meter wide by 2 meters long for today's demonstration, but it can be longer or shorter than 2 meters.

**Step 2**: If the ground has not been used before or is highly degraded and compacted, double dig it.

## Double digging

Double digging is when the topsoil is temporarily removed from the bed, and the subsoil beneath is loosened with a digging fork or hoe as deep as one can dig (try for 30 to 50 cm). Add compost, dry leaves and grass, and sawdust. The topsoil is then placed on top of the organic matter. Double digging should only be done once. Show these videos to illustrate double digging:

- *Double Digging.* Nicholas Heyming.
- *Double Digging.* Peace Corps Senegal.



Double digging steps: Dig up the top layer, using a fork, loosen the next layer, mix the soil with compost and place this on top as the top layer.

**Step 3**: If you do not need to double dig, remove the grass, weeds and debris from the garden site.

**Step 4**: Before adding the soil and organic matter, place the two clay pots with lids into the garden plot area. Note, clay pots can irrigate up to 45 cm (18 in.) of area around them. For a 2-meter long garden, you will need two clay pots. The space between the pots should be 90 cm (36 in.). If you are using clay pots to irrigate crops that love water—such as tomatoes—you need to use a larger pot. The soil and organic matter that will be scooped into the garden bed should be added so it is just below the top of the clay pot. If a lot of the clay pot is exposed, mound soil around the clay pot.

**Step 5**: Use a spade, shovel or hoe to dig up the soil on the outside of the garden and use a shovel to toss it onto the garden site, raising the height of the mound. The area you are scooping from will become the path. Walking paths should be 30 to 60 cm wide (12 to 24 in.). Cover walking paths with mulch to stop weeds from growing.

**Step 6**: Add organic material such as leaves, grass and compost—including cured/ripened manure—and mix it in as you build up the garden. There should be one part compost/organic matter to two parts native soil.

**Step 7**: Rake the mound flat and level so water will not flow off the bed.

**Step 8**: Add water to the clay pot. Then cover the clay pot to prevent evaporation, to stop soil or small animals falling into the pot or drinking from the pot, and to stop mosquitos breeding in the water. Do not use a wooden lid as it will degrade quickly. Also, water the garden bed and allow it to absorb water before planting seeds. Use a stick to monitor how fast the water is draining. When the pot is half-empty, fill it back up with water.

**Step 9**: Now it is time to plant your garden. You can either direct seed or transplant from a nursery. Planting in a triangle pattern helps you use your space more efficiently and crowd out weeds. Each crop has its unique space requirement.

- View video: *Biointensive planting - The triangle method*. Smilinggardener.com.

*When planting vining vegetables like tomatoes or beans, use a trellis, stakes or something similar to support the vegetables. (We will talk more about planting in the next lesson.)*

Staked tomato. *Photo by Andrew M Butler/Flickr. Licensed under CC BY-NC 2.0*

## Maintenance

- **Watering**: Based on the crop and the temperature, watering needs will vary. During the rainy and colder season, watering may be limited. During dry months, raised beds need more watering; you may need to water them daily. Early mornings are best. If clay pots are used, then continue to fill them up and the plants' roots will draw water from them as needed.
- **Weeding**: Because of the deep topsoil, roots are able to deeply penetrate the soil and plants can be spaced more closely, reducing competition with weeds. Triangle planting also helps to out-compete weeds.
- **Compaction**: When planting or maintaining the crop bed, always avoid stepping on the bed as this will compact the soil.
- **Soil fertility**: After harvest, plant residue from the garden can be left to decompose to build up soil organic matter. Additional compost of 10 to 15 cm (4 to 6 in.) deep can be added before the next season.

If available, you can place a barrier on the ground and cover it with 7 to 10 cm (3 to 4 in.) of organic matter to help mitigate weeds.

- Woven bags can be cut and laid out flat over beds. Holes can be cut into the bags for seedlings to be planted in.
- Newspapers, three layers thick, can be laid across and holes cut into the newspaper to allow seedlings to grow. The newspaper will need to be replaced each year.

WARNING: Do not use the glossy pages of a newspaper.

Remind community members: *Because of the rich, loose soil, succession planting and relay planting can be used, which permit harvest year-round. Year-round harvesting is limited by water and labor availability. We will discuss succession planting at our next meeting.*

Ask the following question to understand participants' willingness and ability to build and maintain the raised bed garden. Encourage group members to suggest solutions to these challenges.

**What may limit your ability to build and use the raised bed garden in the upcoming season?**

Listen for any technical support or coordination efforts the project can provide. Listen for any gender issues related to access to and control over resources, workload and decision-making power over using practices.

The DA/CA can use the quality control checklist in the annex when visiting clients' gardens.

Thank the group members for their active participation.

## GARDEN TYPE: SUNKEN BED

**What**: A sunken bed is slightly lower than the surrounding area. Sunken beds are often preferred for plant nurseries.

**Why**: This type of garden is ideal in dry, arid climates or for use during the dry season, as it conserves and diverts water, alleviates water runoff and creates a microclimate that helps keep plants moist, cool and protected from wind. It allows the accumulation of organic material, which reduces water consumption and improves soil fertility.

**Limitations**: Sunken beds need regular watering, so water needs to be accessible during the dry season or irrigation needs to be available. You cannot plant roots and tubers in a sunken garden.

If sunken beds are already used in the community by some members, show a photo of a sunken bed from a similar community in the project zone or use the drawing in the flipbook. Visit the sunken bed if it is in the same village as the training.

**Has anyone built a sunken bed? If yes, ask the questions below:**

- **Can you explain what a sunken bed is?**
- **What benefits did you get from a sunken bed?**
- **What challenges did you face? If you faced a challenge, how did you address it?**

**Equipment**: To build a sunken bed, you need a spade/shovel; organic matter (leaves and grass); compost (plants/manure); 4 sticks; a digging fork for double digging.

**EXERCISE**

## BUILDING A SUNKEN BED

*A sunken bed is typically in the shape of a rectangle (show rectangle shape). It is about 1 meter wide or about the length of a spade/shovel). You should be able to reach from each side of the garden's width to its center without stepping on the bed. If you can't reach, the garden is too wide. The length can vary based on space, labor and water available. To help diversify and stagger planting, you may want to build several separate beds.*

**Step 1**: Use the length of a spade/shovel to measure 1 meter wide by 2 meters long. Use the four sticks to mark the four corners of the garden bed. Remember, the garden can be longer or shorter than 2 meters. The full depth of the garden should be 60 to 75 cm (24 to 30 in.) including the walls.

Measure the length of the spade/shovel to ensure it is about 1 meter long.

**Step 2**: As this garden is below ground level, you will double dig it. Show these videos as an examples of double digging:

- *Double Digging.* Nicholas Heyming.
- *Double Digging.* Peace Corps Senegal.

After showing the videos, have the participants dig up the top layer of soil (about 20 cm or 8 in. in depth), which is relatively easy to dig. Place this soil in a bucket, wheelbarrow, grain sack or a location accessible to the sunken bed. Set aside in another area some of the deeper, nutrient-poor soil for raised pathways or to create a short wall around the bed.

**Step 3**: Using a digging fork, loosen the next layer of soil to about 30 to 45 cm (12 to 18 in.) deep. The loosened dirt in the bed allows for greater water and root penetration. Do not remove this soil.

**Step 4**: Build a dirt wall 30 cm (12 in.) or more above ground for sunken beds on level land. If the land is sloped, then the wall on the downhill side needs to be taller.

**Step 5**: Add a layer of organic matter such as dried leaves, hay or grass, to further enrich the soil.

**Step 6**: Mix the soil with compost and place this on top of the organic matter as the top layer of the bed. There should be one part compost to two parts native soil.

**Step 7**: Water the garden bed before planting so the soil can absorb water.

**Step 8**: Now it is time to plant. If planting vining plants, stalk or trellis them to save space.

**Step 9**: To protect the young plants, you can lay large leaves that are not toxic across the bed.

### Maintenance

- **Watering**: Needs periodic watering (based on crop and weather).
- **Soil fertility**: Organic matter should be added before the next cropping season.
- **Compaction**: Do not walk on the garden bed to avoid compacting the soil.
- **Walls**: Maintain short walls around the bed to prevent nearby erosion and compaction by people and animals.

**NOTE**: Over several seasons, the sunken bed will be filled in with organic matter added or left to rot between seasons. When the sunken garden is filled, you do not need to dig it out again as the soil should be healthy. You can plant in the soil.

Ask the following question to understand participants' willingness and ability to build and maintain the sunken bed garden. Encourage participants to suggest solutions to these challenges.

**What may limit your ability to build and use the sunken bed garden in the upcoming season?**

Listen for any technical support or coordination efforts the project can provide. Listen for any gender issues related to access to and control over resources, workload and decision-making power over using practices.

The DA/CA can use the quality control checklist in the annex when visiting clients' gardens.

Thank the participants for their active participation.

## GARDEN TYPE: KEYHOLE GARDEN

**What**: Keyhole gardens are compact raised-bed gardens—often waist-high—constructed with layers of organic material inside stone walls to improve water retention and soil fertility.

**Keyholes gardens and people with disabilities**
If promoting keyhole gardens to people with disabilities, consider adaptations to the design to accommodate the disability, such as wider keyhole or lower walls if a person is in a wheelchair.

**Why**: Keyhole gardens were designed to be used by people with limited mobility (e.g. the elderly, people with disabilities, and people living with HIV) because once they are constructed, they are easy to manage—no bending and relatively little maintenance is needed.

**Limitations**: Keyhole gardens are labor-intensive to set up and can be expensive depending on available materials. Certain crops are not recommended for the garden, such as tomatoes, peppers, chilies, peas, potatoes, cabbage, eggplant, maize, beans and squash. However, in Ethiopia, tomatoes have been planted near the edges of the garden and hung over the outside like a vertical garden.

If keyhole gardens are already used in the community by some members, show a photo of a keyhole garden from a similar community in the project zone or use the drawing in the flipbook. Visit the keyhole garden if it is in the same village as the training.

**Has anyone built a keyhole garden? If yes, ask the questions below:**

- **Can you explain what a keyhole garden is?**
- **What benefits did you get from a keyhole garden?**
- **What challenges did you face? If you faced a challenge, how did you address it?**

## Equipment/materials

- 2 meter x 2 meter space to build the keyhole
- Local mud blocks, cinder blocks or stones, medium to large, but nothing smaller than a fist
- Spades
- Straw for the central basket
- Small tree branches
- Manure, 4 wheelbarrows (the more manure used, the more productive the garden will be)
- Wood ash, 2 wheelbarrows
- Soil, 8 wheelbarrows
- String or rope, 10 meters

Having participants collect materials before the demonstrations or trainings will save time. Some of the materials can be replaced depending on what is available in the targeted communities.

EXERCISE

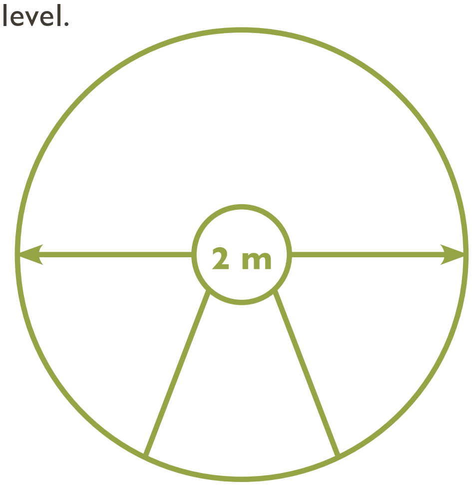
## BUILDING A KEYHOLE GARDEN[2]

Photos by Hassen Mohammed/MCS

If technology is available, show this video:

- *The keyhole garden: A simple key to better nutrition*. Catholic Relief Services.

**Step 1**: Find a site near the home that is 2 x 2 meters in size and is level.




**Step 2**: Collect stones, branches, manure, ash, and grass or leaves, and weave a simple basket of straw (barley, wheat and teff, but not maize as it does not allow for water to drip).

**Step 3**: Lay out the space for the garden. Determine where the center of the garden should be. Use a spade to measure 1 meter in four directions from the center and mark those points. Then draw a circle connecting the four points, which will be 2 meters (two spade lengths) in diameter.

**Step 4**: Place the woven basket in the center of the circle. Form a frame around the basket with three or four large sticks to hold it in place and prevent it from collapsing as layers of soil and organic material are added.

**Step 5**: Scratch the surface of the soil within the circle to loosen it.

**Step 6**: Place stones around the edge of the circle. As you build up your layers of soil and organic material, you will add to the stone wall as you go and keep the basket upright in the center of the garden. Keep moving the basket up with each layer.

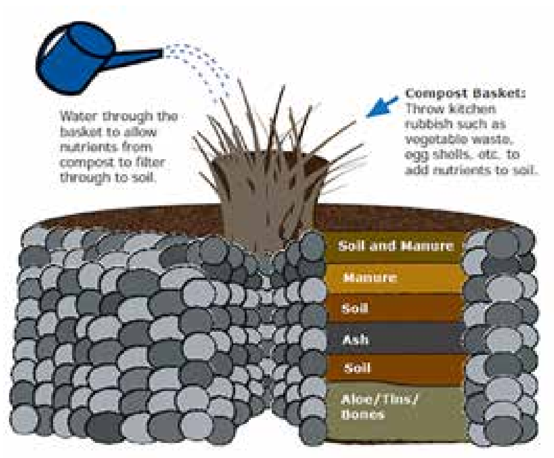
**Step 7**: Place a first layer of leaves, branches, cardboard or tin cans.

2. The equipment list and exercise are from *Homestead gardening: A manual for program managers, implementers, and practitioners*. 2008. CRS.

**Step 8**: Add a layer of soil (4 wheelbarrows) on top of those, then add a thin layer of ash (1 wheelbarrow)

**Step 9**: Add another thin layer of soil (4 wheelbarrows), then a thick layer of manure (2 wheelbarrows).

**Step 10**: Add the top layer where the seeds will be sown, using a healthy mixture of soil (4 wheelbarrows), ash (1 wheelbarrow) and manure (2 wheelbarrows) or compost (about a 1:1 ratio).

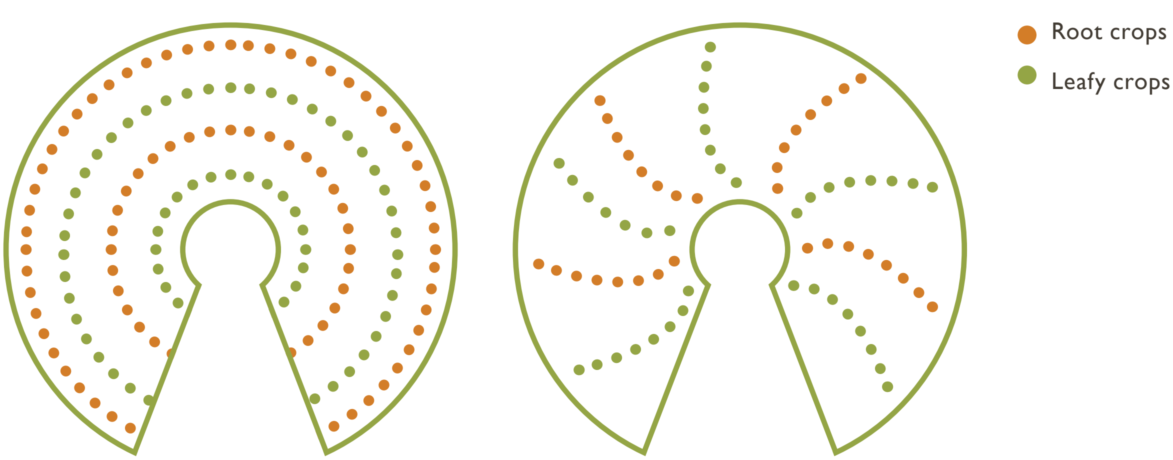



**Step 11**: Slope the top layer slightly, like the roof of a house, to keep it from sinking toward the middle of the keyhole.

**Stop 12**: Now it is time to plant!

It is preferable to grow a minimum of four types of crops to promote a diversified diet and to help control pests. Alternating rows between the four, with root crops followed by leafy crops, uses space efficiently and reduces the strain on soil fertility. Also, alternating rows help to control pests, which may attack one type of plant but not the others.

### Keyhole garden planting patterns



Crops should be planted in a circle parallel to the walls of the garden or in curves from the center. Curved lines are generally preferred to make it easier to weed between the rows. This planting structure keeps the topsoil from running off when the garden is watered.

Use mixed cropping, alternating rows of leafy crops and root vegetables such as carrots and beetroot to minimize nutrient loss.

### Maintenance / key points to convey

**Irrigation and watering**: *The garden will need to be watered daily. You can pour greywater into the basket to water the layers beneath. Clean water can be applied to the top layer as in conventional gardening, when needed.*

?

- **What is greywater?**
- **Do you have any concerns about using greywater?**

Listen carefully for the following: It is waste water from bathing, cooking and washing clothes that is not contaminated with feces. The water may contain small pieces of dirt, food, grease or hair. The water is safe if it contains ammonia cleaners. The water shouldn't have cleaning products that use bleach, bath (sodium) salts, artificial dyes, chlorine-based cleansers, strong acids or solvents.

- Most greywater should be assumed to contain germs; for safety, avoid skin contact with greywater. Wash hands after applying greywater to ensure proper personal hygiene.
- Greywater used to clean dirty diapers/nappies should not be used for gardening.
- Ensure the greywater is applied directly to the soil and not sprayed, as there is a danger of inhaling the water as an aerosol or contaminating the crops. Vegetables and fruit contaminated with greywater may cause illness if they are eaten raw or not washed, cooked or peeled properly.
- Do not store greywater for more than 24 hours, as it will create bad odors.

### Soil fertility

- Kitchen scraps and rotted manure should be placed inside the center basket to help renew the nutrients in the soil.
- Rotted manure should be added to the topsoil to renew the nutrients. It should be added when the rotted manure is no longer visible on the top layer.
- Compost can be added instead of rotted manure or used between the rows as mulch.
- The garden will sink over time as the layers of organic material decompose. Some soil should be added from time to time to maintain the level.

**Thinning**: Plants need to be thinned out after germination to allow enough room for growth. Thinning out the rows helps to reduce competition for moisture and nutrients, allowing the crops to grow better.

**Basket**: Every one to two years, the center basket will need to be replaced. To replace it, remove the stones from the walkway. The old material can be pushed to the bottom, as the organic matter will decay to become humus and add nutrients to the soil.

Ask the following question to understand participants' willingness and ability to build and maintain one of these gardens in the upcoming season. Encourage participants to suggest solutions to these challenges.

**What may limit your ability to build and use one of these gardens in the upcoming season?**

Listen for any technical support or coordination efforts the project can provide. Listen for any gender issues related to access to and control over resources, workload and decision-making power over using practices.

The DA/CA can use the quality control checklist in Annex 4 when visiting clients' gardens.

Thank the participants for their active participation.

## GARDEN TYPE: PERMAGARDEN

Photo by Thomas Cole

**What**: A permagarden consists of raised or sunken beds, swales and berms to manage water, and fencing. A swale is an on-contour depression dug to ensure water slows and filters into the soil instead of running over it. A berm is a raised earth mound running across a slope.

**Why**: It is designed to work in both the rainy and dry seasons, and is an approach to home gardening that improves soil fertility and water management to produce nutritious crops.

**Limitations**: The design stage is more intensive than some of the other gardens that have been described. Its maintenance will likewise require more time, care and attention from the gardener.

> If permagardens are already used in the community by some members, show a photo of a permagarden from a similar community in the project zone or use the drawing in the flipbook. Visit the permagarden if it is in the same village as the training.

**Has anyone built a permagarden garden? If yes, ask the questions below:**

- **Can you explain what a permagarden is?**
- **What benefits did you get from a permagarden?**
- **What challenges did you face? If you faced a challenge, how did you address it?**

If the community members want to learn how to build a permagarden, there have been a number of permagarden trainings held within Ethiopia so you could seek support from those already trained or use the USAID TOPS ***Permagarden Technical Manual*** (pages 11-14).

Ask the following question to understand participants' willingness and ability to build and maintain one of these gardens in the upcoming season. Encourage participants to suggest solutions to these challenges.

**What may limit your ability to build and use a permagarden in the upcoming season?**

Listen for any technical support or coordination efforts the project can provide. Listen for any gender issues related to access to and control over resources, workload and decision-making power over using practices.

Thank the participants for their active participation.

ANNEX 4

# GARDEN CHECKLIST

Field agent name: ____________________________________________

Gardener name/ID number: ____________________________________

Gardener's gender (circle): Male Female

Location: ___________________________________________________

Date:_______________________________________________________

### Quality control checklist: General garden aspects

| Criteria | Agent's observation | Agent's recommendation to gardener | Follow-up visit status |
|---|---|---|---|
| Crops planted are compatible with each other | | | |
| Crops look sufficiently watered | | | |
| Soil is enriched with organic matter | | | |
| Are pests detected? If so, identify the pests | | | |
| Are diseases detected? If so, identify the diseases | | | |
| Plants do not show signs of nutrient depletion | | | |
| Weeds are under control | | | |
| Plant residue remains on garden bed | | | |

### Raised bed

| Criteria | Standard | Agent's observation | Agent's recommendation to gardener | Follow-up visit status |
|---|---|---|---|---|
| Climate | Needs wet climate/season, as difficult to manage water during dry season | | | |
| Shape | Preference is rectangle | | | |
| Width | Gardener can reach center easily without stepping on soil (width of about 1 meter) | | | |
| Length | No standard length | | | |
| Depth | 16-20 cm minimum | | | |
| Soil enriched with organic matter | Yes, with leaves, grass, composted plants and animal manure; topsoil | | | |
| Frame strength | Able to support soil and water | | | |
| Pathway coverage | Covered in mulch | | | |
| Pathway width | Wide enough so gardener can walk with tools without disturbing beds (60-90 cm) | | | |
| Soil compaction | None | | | |
| Tillage | None | | | |
| Suggested crops not to grow | Large, vining plants (i.e. squash) unless staked/trellis | | | |
| Planting design | Triangle | | | |
| Planting | Succession planting | | | |
| Water | Nearby through natural/ human-made means or irrigation, especially during dry season | | | |

## Sunken bed

| Criteria | Standard | Agent's observation | Agent's recommendation to gardener | Follow-up visit status |
|---|---|---|---|---|
| Climate (dry/ wet) | Dry, arid climates. Not for areas that flood or during rainy season | | | |
| Bed construction | Double digging used to construct bed only<br>Wall height is at least 30 cm (12 in.); if on sloped land, wall should be higher | | | |
| Width | Gardener can reach center easily without stepping on soil (about 1 meter) | | | |
| Length | No standard length | | | |
| Depth | 45-60 cm (18-24 in.) | | | |
| Soil enriched with organic matter | Yes, with leaves, hay, grass | | | |
| Pathways | Raised; made with nutrient-poor soil | | | |
| Pathways width | Wide enough so gardener can walk with tools without disturbing beds (60-90 cm) | | | |
| Soil compaction | None; not walked on | | | |
| Level of erosion around bed | Walls maintained | | | |
| Suggested crops not to grow | Roots and tubers | | | |
| Planting | Vining plants are stalked/ trellised | | | |
| Water | Regular watering | | | |

### Keyhole garden

| Criteria | Standard | Agent's observation | Agent's recommendation to gardener | Follow-up visit status |
|---|---|---|---|---|
| Climate (dry/wet) | Dry | | | |
| Bed construction | Keyhole garden is on flat land | | | |
| Bed construction | Walls of keyhole garden are strong | | | |
| Bed construction | Layers of soil content include manure, ash, rotting logs, dry and green grass or leaves, and other available organic materials.<br>Top layer of keyhole garden is sloped.<br>Basket in center is in good condition. | | | |
| Size | 2-meter circumference | | | |
| Depth | Waist high; adapted based on disability | | | |
| Soil fertility | Household organic (kitchen) waste is added to the central basket to enrich soil; manure is aged | | | |
| Access path | Keyhole large enough for gardener to get access to basket | | | |
| Suggested crops not to grow | Peppers, chilies, eggplant, maize, cabbage and large/vining plants (beans, squash, pumpkin, peas) | | | |
| Planting design | Circular | | | |
| Water | Greywater poured into basket. Watered more often during dry season. | | | |

See USAID TOPS *Permagarden Technical Manual* for quality guidance.

LESSON PLAN 6

# PLANTING

| | |
|---|---|
| **What**: This lesson plan covers important aspects to ensure the vegetable crops are planted properly.<br>**Why**: Vegetables will produce the most when planted at the right depth and spaced correctly, in the correct amount of sun, at the right temperature, and with other plants that support them.<br>**How**: Review key factors that influence crop planting through discussion and then practice planting selected crops in the demonstration garden. | |
| **Planning**: Determine how to obtain adapted or certified seeds when available to demonstrate planting. | **Materials**: Adapted/ certified seeds, shovel and triangle. |
| **Timing**: 45 minutes to discuss, 30 minutes to plant | |

If the demonstration on how to build the garden happens before it is time to plant and there is no water for irrigation or the temperature is not warm enough, then discuss the practices but do not plant the seeds as they will not grow properly.

### Ask

When asking the following question, seek responses from many participants to understand the different perspectives among community members. Allow men and women to provide responses without judgement. This question will help you understand the participants' understanding of planting practices used.

**How do you determine when, where and with what other plants to plant your vegetables?**

Listen carefully and take note of responses related to the points below. Their level of knowledge will guide you as to how much detail to use in the next section.

1. Level of sun exposure/shade required for each crop
2. Spacing between plants and planting depth of seeds
3. Temperature of the soil and the air
4. Crops that support each other (compatible) or crops that don't grow well together (incompatible)
5. Succession planting

For the crops the project is promoting, there is a table on Page 60 that provides information on all of these aspects.

Where possible, we encourage the use of adapted or certified seed for drought resistance and fast-maturing seeds.

After asking this question and encouraging discussion, move to the next section.

### Show and explain

*There are five key things to consider when deciding when, where and with what other plants to plant your vegetables* (read from the above list). *During our discussion, some of these ideas came up. We will take some time to understand each and then we will practice planting seeds for selected crops.*

**A few meetings ago, we discussed that plants need different levels of sun. Why is it necessary to understand how much sun each vegetable crop needs?**

Listen carefully and take note of responses related to the points below. Mention any that are not raised during the discussion.

- All plants need sunlight as this is what makes them grow.
- Plants need different levels of sun:
  - Full sun: 6 to 8 hours of direct sun all day.
  - Partial sun/partial shade: Less than 6 hours and no direct sun in the afternoon as it will burn the plant. Consider sunlight filtered through tree branches.
  - Shade: No direct sun.

**Why is it necessary for crops to be spaced correctly?**

Listen carefully and take note of responses related to the points below. Mention any that are not raised during the discussion.

- Proper spacing reduces competition for light for sun-loving plants.
- Proper spacing reduces competition for soil nutrients. Remember to keep the area weed-free as weeds also compete for the soil nutrients.
- If roots are crowded, growth will slow.

The local DA should be able to tell you proper crop spacing based on non-mechanized plots.

**How does the soil and air temperature effect planting and crop growth?**

Listen carefully and take note of responses related to the points below. Mention any that are not raised during the discussion.

- Crop seeds need different temperatures to germinate.
- If a plant gets too hot or too cold based on its needs it may not fruit well.
- When a cool-season plant gets too hot, it may go to seed.
- The wrong temperature may affect the taste of the produce.

For example, cabbage grows best at 15˚to 18˚C (60˚to 65˚F), but it will grow at temperatures as low as 7˚C (45˚F) and as high as 26˚C (80˚F). Temperatures higher than 26˚C (80˚F) will cause cabbage to bolt and flower.

**What do you know about plants that support each other (friendly/compatible) and plants that don't work well together (enemy/non-compatible)?**

Listen carefully and take note of responses related to the points below. Mention any that are not raised during the discussion.

- Plants that work well together increase productivity because they support each other through:
  - Pest control (i.e. garlic)
  - Pollination
  - Attracting beneficial insects
  - Maximizing space
- Plants that don't work well together may:
  - Have different environmental needs such as water requirements
  - Compete for the same nutrients or sunlight
  - Attract insects that are harmful to the other plant

**What is succession planting and what do you know about it? If you succession plant, why do you do it?**

### Succession planting

Listen carefully and take note of responses related to the points below. Mention any that are not raised during the discussion.

- Requires sowing vegetable seeds every few weeks so there are multiple harvests.
- Involves planting a quick-maturing crop close to a slower-maturing crop.
- Ensures dietary diversity throughout the season.

**? What can we do during planting of crops that can help us protect our gardens from pests and disease?**

Listen carefully and take note of responses related to the points below. Mention any that are not raised during the discussion.

- Use pest and disease-free planting material.
- Sanitize tools and stakes with clean water and soap, and air dry them; burn metal tools with fire or use alcohol to disinfect the surface of tools.
- Use correct spacing between crops.
- Rotate crops.
- Plant companion crops.
- Trellis vining crops (i.e. tomatoes) to increase air flow, making them less inviting to disease.

*Now that we have reviewed the key factors to consider when planting, we also need to make sure the seed we are planting has a good germination rate. Even if you bought seeds in a store recently and the expiration date is still far into the future, it is good to test the seed's potential germination rate as it is not often stored in the perfect environment. We will now demonstrate how to test your seed's germination rate at home.*

When demonstrating this with community members, prepare samples of the seed to show what it looks like at three days and seven to ten days as you won't be able to come back in three days and/or seven to ten days to see the progress.

- First, mix up the seed in the container as seed in different parts of the container will experience different levels of heat and moisture.
- Count out a round number of seeds such as 100 (ideal), 50 (good) or 10 (OK if little seed can be spared).
- Wet a piece of thick paper towel, clean rag or coffee filter. Newsprint paper works too but is less preferable because it is harder to see the seeds.
- Space the seeds evenly on half of the material and fold over or roll up carefully and tightly to enclose them.
- Put the material with seed (referred to as the "test" below) somewhere safe and warm and away from insects.
- Keep it moist by spraying or by storing the test in a plastic bag.
- After three days, open the test. Count and remove seeds that have sprouted and look similar to all the other seed. Very abnormal seeds would probably not survive in the garden. Close the test again.
- Between days 7 and 10, open up the material and count the number of seeds. Add this total to the number counted on day 3. This is the portion of the seed that has sprouted. Divide by the total number of seeds included in the test to calculate germination percentage.
- If you test the seed coming from the same source over time and note that more seed is taking longer to sprout, that is a sign of reduced vigor and impending germination decline.

A simple, illustrated home seed germination testing lesson designed for children is found in Agricorps' school garden curriculum. A guide with good photographs and some alternate methods is found at Southern Exposure Seed Exchange's How to Test Germination.

?

- **Are there any new ideas from today's session that you will try in your garden?**
- **Do you see any challenges in trying this idea?**

Listen for any technical support or coordination efforts the project can provide. Listen for any gender issues related to access and control over resources, workload and decision-making power over what and how to store. Take note and bring back to the project team.

## Summary of key characteristics of promoted crops

| Crop | Temperature | Space between plants | Sun Exposure | Don't plant near … | Plant near .. | Soil type | pH level | Seed saving | Succession planting | Key nutrients |
|---|---|---|---|---|---|---|---|---|---|---|
| Cabbage | Optimum temperature: 15˚-18˚C (60˚- 65˚F)<br>Will grow at 7˚-26˚C (45˚- 80˚F.)<br>Above 26˚C (80˚F), it will bolt and flower | 30-60 cm (12-24 in) apart in rows. The closer they are planted, the smaller the head | Full sun | Tomatoes, strawberries<br>Broccoli and cauliflower (same family, each require lots of the same nutrients, attract pests and disease) | Beet, lettuce, onion and potato | Sandy loam to clay soil | 6.0 - 7.0 (neutral) | Difficult | 21-day intervals | Vitamin K, folate |
| Carrots | Fastest root growth is at 15 ˚C-18˚C,<br>Shoot growth – slightly higher temperature<br>Seed germination: at least 10˚C | 7.5-10 cm (3-4 in) apart; rows 30cm (12 in) apart | Full sun; tolerate shade | Anise, dill, parsley | Cabbage, lettuce, onions, pepper, tomato and beans | Sandy/loam soil | 5.5 - 7.0 | Moderate | 21-day intervals | Vitamins A, B6 and K, biotin, potassium |
| Kale | Optimal soil temperature: 15˚-18˚C (60˚- 65˚F)<br>Prefers cool temperatures and will be sweetened by a touch of frost. | 20-30 cm (8-12 in) | Full sun | Strawberries, tomatoes | Beet, lettuce, onion, potato and garlic | Well-drained; many soils, but prefers loams | Tolerates 6.0-7.5; Prefers 6.5 - 6.8 | Moderate/ difficult | Continuously produces if soil kept wet and cool | Vitamins A, C and K, protein, fiber, folate |
| Orange-fleshed sweet potato* | Optimal temperature: 20°-25˚C<br>Can grow at 15°-35˚C. Highest root yields: Day temperature of 25°-30˚C; night temperature of 15˚-20˚C | 25-30 cm (8-12 in) between plants and 60-100 cm between ridges | Full sun | Cassava, but most crops because of the spread of the orange-fleshed sweet potato | Beans, soybeans and peas (intercropped) | Many soils, but prefers fine sandy loam or well-drained clay loams | Tolerates 4.5 - 7.5<br>Prefers 5.8 - 6.2 | VPC | Roots can be harvested over several months for home consumption so succession planting unnecessary | Vitamins A, B6, B5 and C, fiber, potassium, manganese |
| Swiss chard | Seed germinates from 40˚F-95˚F, optimal temperature is 85˚F<br>Prefers cool weather, but will grow slowly in warm weather | Plant 6-12 in. apart; rows 18 in. apart; Half-inch deep | Full sun during cool part of season/ Partial sun during hot season | Most herbs, potatoes, corn, cucumbers and melons | Chinese cabbage, cabbage, beans, onions and tomatoes | Loamy soils | 6.0-7.0 | Difficult | Continuously produces (harvest from outside leaves) | Protein, fiber, Vitamins A, C and K; magnesium, manganese, iron, and potassium |
| Tomatoes | Grow best with daytime temperature of 18˚-29˚C (65˚-85˚F).<br>Stops growing above 35˚C (95˚F).<br>If nighttime temperatures are above 85˚F, the fruit will not turn red. | 60cm (24 in) | Full sun | Corn, dill and potatoes | Broccoli, brussels sprouts, carrots, cabbage, cauliflower, corn, kale, onion, pepper and potatoes | Loams and sandy loams | Tolerates 5.5 - 7.5<br>Prefers 6.0 - 6.8 | Moderate/ difficult | 14-day intervals | Vitamins C and K, potassium and folate |

* For details on OFSP, read Everything you ever wanted to know about sweetpotato.

| Crop | Temperature | Space between plants | Sun Exposure | Don't plant near … | Plant near .. | Soil type | pH level | Seed saving | Succession planting | Key nutrients |
|---|---|---|---|---|---|---|---|---|---|---|
| Green hot pepper (Karia) | Rainfed conditions (1,400-2,000 meters) | - | - | Beans, kohlrabi | Carrot, onion tomatoes | - | - | - | - | Vitamins C and A, and iron |
| Onions | Grow best at 13°C-25°C (55°F-75°F)<br>Produce higher-quality bulbs with cool weather during their early growth stage, then increased temperatures for optimum maturity | 10-12.5 cm (4-5 in) apart in rows 30-45 cm (12-18 in) apart | Full sun | Beans, peas, sage | Beet, cabbage family, carrot, chard, lettuce, pepper, strawberries and tomatoes | Sandy soil | 5.5-6.8 | Difficult | - | Vitamins C and B6, folate and potassium |
| Garlic | Seed needs 40 days at or below 4°C (40°F) before planting | 15-20 cm (6-8 in) | Full sun | Peas and beans | | Sandy soil; well drained | 5.5-8.0 | Seed once every 2 years | - | Magnesium, vitamins B6 and C |
| Beet roots | Cool/warm | 2.5cm (1 inch) apart in rows 30-45cm (12-18 in) apart | Full/partial sun | Field mustard and pole beans | Garlic, bush beans, cabbage, lettuce and onions | Loam soils or sandy soils | 6.0-7.5 | Difficult | 14-day intervals | Greens: Vitamins A and C, and protein<br>Roots: Folate, manganese, potassium, iron and vitamin C |
| Pumpkin | Soil temperature is 18°C (65°F) and night air temperatures are above 12°C (55°F).<br>Grows best in air temperatures 10°-32°C ( 50°-90°F). | 5-7.5 cm (2-3 in) on a hill<br>8-12 foot apart rows | Full sun | potatoes | Corn, melon and squash | Loam/ sandy soil | 5.5-7.5 | Moderate | | Vitamins A and C, and fiber |
| Pigeon pea | Prefers 18°C-30°C , but can grow in >35°C with good soil moisture and fertility | 12 in. apart<br>1-inch deep | Sun or shade | Garlic, onions, shallots | Beets, cabbage, carrots and potatoes | Any soil | 5.0-7.0 | Easy with stem cuttings | perennial | Protein, fiber and folate |

LESSON PLAN 7

# PROTECTING YOUR GARDEN FROM PESTS AND DISEASE

**What**: Integrated pest management is a broad crop management approach that integrates cultural, biological, physical and chemical practices to control disease and pest populations below established thresholds.

**Why**: Pests and disease can affect any garden, resulting in the loss of a harvest. This means less food to eat in the household. It also means a risk of exposure to dangerous chemicals such as pesticides.

**How**: A series of discussion questions and the sharing of information.

**Planning**

Based on the list of crops to be promoted and used in the garden, identify the pests and diseases affecting these in the targeted area and gather information on how to prevent or control them.

Prepare a list of companion crops for pest prevention for the selected crops.

**Timing**: 75 minutes

**Materials**

If illustrating one of the biopesticides shared in Annex 5, you will need the inputs for this demonstration.

For pests and diseases identified but not included in this lesson plan, you will need to gather information about them as well as photos. For further information and illustrations of pests and diseases, visit this link for a list of online resources.

## Ask

When asking the following questions, seek responses from many participants to understand the different perspectives among community members. Allow men and women to provide responses without judgement. These questions will help you understand what pests and diseases community members are encountering or have recently encountered.

**? What pests and plant diseases are in your fields and gardens?**

Listen carefully to the responses and take note of any pests and diseases the community has recently faced or is facing. Determine which are applicable to the crops being grown/promoted and gather information to share with them during future meetings if not currently known.

### Show and explain

*We can use an approach called integrated pest management (IPM) to manage pests and disease. With integrated pest management, there are five steps you can take to manage pests and disease.*

**What do you know about integrated pest management?**

Listen carefully to the existing knowledge the community members have about integrated pest management. Ensure all community members have a similar level of understanding. If there is a similar level of understanding, then tailor this lesson to address any incorrect information shared and to cover steps where less information is known by the community members.

Steps 1 to 5 provide the general approach. Specific information on selected pests and diseases can be found in Annex 5. Use this information based on what pests and diseases the community is encountering.

The five steps of integrated pest management are:

- Step 1: Prevent
- Step 2: Monitor
- Step 3: Identify
- Step 4: Assess damage and determine when to act
- Step 5: Implement pest and disease management strategies

Remember you do not need to review all the steps. Select the steps to review based on the current knowledge identified during the earlier discussion.

### Step 1: Prevent

*Let's build our gardens so we prevent pests and diseases from the start.*

**What can you do to protect your gardens from pests and disease?**

Listen carefully to the responses. Acknowledge actions that prevent pests and disease, correct any information that is inaccurate, and share practices community members can use that they have not mentioned. Here is a full list of practices:

- Use pest- and disease-free planting material.
- Sanitize tools and stakes with clean water and soap, and air dry them. They can also be sanitized by burning them with fire or rubbing them down with alcohol to disinfect.
- Apply mulch to contain weeds.
- Use correct spacing between crops.

- Rotate crops.
- Plant companion crops.
- Apply mulch and avoid overwatering to reduce splashing soil containing disease onto the leaves.
- Remove weeds before they reproduce.
- Trellis vining crops (i.e. tomatoes) to increase air flow, making them less inviting to disease.
- Follow good agricultural practices related to soil fertility and water management as healthy plants are better able to withstand pest and disease damage.
- Avoid over-application of nitrogen fertilizer, which can attract some pests.

### Step 2: Monitor

*Once you have done everything you can do to prevent pests and disease, you need to monitor for them. This is also known as scouting.*

*Let's play a game!*

*This game will help us share what we know in general about monitoring for pests and disease and to learn from each other.*

Supplies: An item to grab (piece of cloth, garden tool, etc), list of questions

- Form two teams.
- The DA/CA reads each question to the teams.
- The team with an answer runs to the item and picks it up and provides the answer.
  - If the answer is correct, the team gets one point.
  - If the answer is incorrect, the other team can provide a response. If the response is correct, that team gets one point.

Recognize the group's efforts to share and learn about monitoring through this game and then proceed to the next question.

- **How often should we monitor or "scout" for pests?**
  *Answer: Twice a week*
- **What time of day should we scout for most pests and why?**
  *Answer: Usually very early in the morning, as this is the time when night insects are still out, and daytime insects are becoming active. But, with certain pests, you may need to monitor them at different times to catch them.*
- **Where should you look for pests?**
  *Answer: Usually on the underside of leaves because this is where most pests are found.*

**Do you think insects are beneficial to your gardens? If so, which insects?**

Listen carefully for positive responses. There are insects that are beneficial to the garden; note which the community members believe are beneficial and why.

Some examples are:

- Honey bee: Pollination
- Ladybirds and ants: Eat aphids and earwigs

### Step 3: Identify pests and diseases

*If you have found a pest or disease in your garden, you need to identify it so you know how to treat it. If there is a pest and disease that you do not know, consult the DA or woreda's plant protection expert.*

### Step 4: Assess damage and decide when to act

*Now you have found a pest or disease and identified it, you need to decide whether action is needed.*

- Mild/little damage (20 to 30 percent of the plant's leaves are brown or falling off. This level of damage does not lead to major yield loss, so you should monitor it, but no follow-on action is needed.
- Mature, healthy plants can tolerate more damage than seedlings or transplants, so you may need to take action earlier for young plants.

### Step 5: Implement pest- and disease-control strategies.

There are four types of control strategies: 1) Cultural, 2) biological, 3) physical and 4) chemical:

- **Cultural control**: These are the actions we talked about earlier today for preventing pests and disease, such as sanitizing tools, rotating crops, spacing crops correctly and so forth.
- **Biological control**: This involves using the natural enemies or beneficial insects that we discussed earlier today that attack harmful insects, mites and other pests.

- **Physical control**: This is the removal of pests from plants and removal of diseased plants from the garden to prevent further damage from occurring or spreading. Some practices are:
  - Handpicking slow-moving insects that do not sting, bite or pinch. Place the insect in a cup of soapy water to kill it quickly.
  - Constructing a physical barrier around the garden or some plants/trees to prevent entry. Very useful during the nursery stage of seedling production.

**What do you use as a physical barrier to prevent pests?**

Listen carefully for local options of physical barriers being used. Some include net houses, metal or paper collars, but these may not be available locally.

- **Chemical control**: *Having tried all the methods we have talked about and failing to control a specific pest, you may want to explore some chemical controls. One option is to use biopesticides, which are made from natural materials such as plants and animals. Many can be made at home. For example, use the pests you removed from the plants under physical control, and pound a cupful with water to make a paste. Spread the "bug juice" across the garden. It will attract predators capable of attacking future pest populations.*

**What type of biopesticides do you use?**

Listen carefully for examples of locally made biopesticides and how well they work. Listen for mentions of neem leaves (not neem oil) and insecticidal soaps. Acknowledge the locally available biopesticides and then proceed to "chemical pesticides."

Annex 5 contains instructions on how to make several biopesticides.

*Chemical pesticides can be harmful to human and animal health as well as soil and water quality; therefore, any use of pesticides should be done with caution, following proper scouting and after determining that the pest damage is not tolerable. It is our recommendation that you hire someone trained to apply pesticides as each pesticide is different and has specific instructions on how it is to be correctly used. If you use chemical pesticides, there are a few safety guidelines to be aware of that vary for each product, so it is important to know what product you are applying.*

## Safety guidelines

- **Re-entry periods**: This is when it is safe to go back into the garden or field after the pesticide has been sprayed. This varies by pesticide so ask the seller or the vendor who is applying the spray what the timeframe is for re-entry. If you go into the field barefoot, you will need to wait longer than suggested. Communicate this information to family members so they do not enter the field too soon.
- **Signal words**: If the pesticide is in its original bottle, the label may indicate its level of toxicity: **Caution** (slightly toxic), **Warning** (moderately toxic), **Danger and Danger-Poison** (Highly toxic). Note that even slightly toxic products can pose a high risk if someone is exposed to a large amount.
- **Proper mixing and application**: The toxicity of a pesticide depends on its concentration. Therefore, it is important to follow the guidance on its proper mixing and application.

- **Use of safety equipment**: Protective equipment should be worn when applying pesticides, to minimize exposure to harmful chemicals. Pesticides can cause harm through contact with the skin or eyes, being swallowed or breathed in. Do not touch it with your bare hands.
- **Storage**: Always store pesticides in designated containers that cannot be easily confused for something else, and place them out of the reach of children.
- **Triple washing**: When cleaning an empty pesticide container, triple rinse the container and do not reuse it. Ensure that leftover chemicals and containers are properly disposed of according to the instructions on the bottle.
- **Counterfeit and poor-quality products**: Fake, counterfeit and ineffective products are common in the market place because of a lack of proper storage and poor regulations and oversight.
- **After applying pesticides**: Wash yourself and your hands thoroughly.

? **What pest and disease prevention and control practices are you willing to try? What might stop you from trying these practices?**

Listen for any technical support or coordination efforts the project can provide. Listen for any gender issues related to access to and control over resources, workload and decision-making power over using practices.

## ANNEX 5

# RESOURCE FOR FIELD AGENTS ON PESTS AND DISEASE

For further information and illustrations of pests and diseases, visit this link for a list of online resources.

## PESTS

### CUTWORM

**Crops**: Young beans, cabbage, corn and lettuce.

**When to find them**: Dusk/evening hours

**Damage**: Feeds on leaves, cutting stems at or near the surface.

#### Prevent cutworm

- Natural predators: fireflies and birds.
- At end of the season, till the garden.
- Remove weeds and grass three weeks before planting.
- Use plant collars.

#### Control cutworm

- Hand pick at night. Drop them into soapy water to kill them. Repeat every two to three nights.
- Sprinkle used coffee grounds or eggshells around your plants.
- Water in the morning.

### APHIDS

**Crops**: Squash, cucumber, pumpkin, melon, bean, potatoes, lettuce, beet, chard and bok choy.

**Where to look**: Under the leaf.

**Damage**: Attacks all parts of the plant depending on species. Look for misshapen, curling, stunted or yellowing leaves and/or deformed flowers and fruit. Branches and leaves may be black.

#### Prevent aphids

- Spray dormant horticultural oil on aphid eggs.
- Beneficial insects: Lady beetles, lacewings and parasitic wasps.
- Beneficial companion plants: Marigolds, calendula, sunflower, daisy, alyssum, dill, catnip, garlic and chives.
- Plants that attract aphids are mustard and nasturtiums.

#### Control aphids

- Spray cold water on plants.
- The following can be applied to the plant/insects: Flour, insecticidal soap every two to three days for two weeks, neem oil or horticultural oils.

## SCALE INSECTS

**Crops**: Fruit trees, not vegetables.

**Where to find them**: Plant stems, twigs, trunks, foliage or fruit.

**Damage**: Adhere to the stems and branches to feed off the plant's sap.

### Prevent scale insects

- Remove affected branches and leaves.

### Control scale insects

- Predators: Soldier beetles, ladybugs/lady beetles, lacewings and parasitic wasps.
- Remove affected branches and leaves.
- Hand pick them from the plant.
- Apply horticultural oils to the entire egg or insect.
- Apply insecticidal soaps several times to the entire egg or larvae.

## PLANT-PARASITIC NEMATODES

(e.g. root knot nematode and cyst nematodes)

**Crops**: Tomatoes, peppers, cucumber, squash, eggplant, okra, beets, carrots, English peas, lettuce, potato and radish.

**Where to find them**: Roots of plants, but need a microscope to see them so look for symptoms described below.

**Damage**: Swelling of roots; consumes the plants' water and nutrients, plant may wilt, have yellow leaves, not grow as much, or die (if heavily infested).

### Prevent nematodes

- Use crop rotation.
- Plant disease-resistant varieties.
- Use clean plants and soil, and do not replant from soils infested with nematodes to soils without nematodes.
- Do not allow irrigation water from nematode-infested areas to run onto areas without nematodes.

**Control nematodes**: Very difficult so the aim is prevention using the techniques described above.

## Preparation of natural sprays

### Preparation of neem leaves

Neem leaves can be dried and mixed with the grain. For the field, a neem-based spray can be applied before an outbreak:

- Cut leaves into fine pieces.
- Mix 1 kg of leaves with 5 L of water.
- Leave the mixture for one day.
- Filter out the particles and use the liquid.

### Insecticidal soaps

1. Use a clean spray bottle. Sanitize any used bottles thoroughly.
2. Combine 3.7 L (1 gallon) of water with 4 to 5 tablespoons of liquid soap (no bleach, fragrance, moisturizers or chemicals).
3. Test on a few plants.

# DISEASES

## RUST DISEASES

**Crops**: Tomatoes and beans.

**Description**: A fungal parasite.

**Damage**: Top of plant leaves will have yellow or white spots while the underside will have reddish to orange swellings or orange/yellow spots/streaks.

**Transmission**: Spores spread by wind and water.

### Control rust (Very difficult)

- Remove and destroy all infected plant parts.
- Clear path between plants to prevent rust spreading.
- Do not splash water onto the leaves.

### Prevent rust

- During the early season, dust plants with sulfur.
- Space plants properly to encourage good air circulation.
- Water at the roots and not on the leaves.

## BLIGHT

**Crop**: Tomatoes and potatoes.

**Description**: Initially will appear on the oldest leaves closest to the ground. It appears as irregularly shaped spots with concentric rings and maybe a dot in the middle.

**Damage**: Infected leaves will turn brown. If more than half the plant is infected, the plant will be weak but will not die.

**Transmission**: Spores spread by wind and water.

### Prevent blight

- Use blight-resistant varieties.
- Rotate crops.
- Proper spacing to ensure full sun and proper drying of leaves.
- Remove infected leaves.
- Apply mulch to avoid soil splashing when watering or raining.
- Do not wet the leaves when watering.
- Once plant is fruiting, cut off lower three or four branches of leaves.
- Remove infected plants at end of season.

### Control blight

- Prune lower leaves to slow the spread of the disease.
- Remove infected leaves.

## POWDERY MILDEW

**Crops**: Beans, beet, carrots, cucumber, eggplant, lettuce, melons, peas, peppers, pumpkins and tomatoes.

**Description**: Fungal disease appears as white, powdery spots on leaf surfaces, shoots, flowers and fruit. For onions, peppers and tomatoes, yellow patches on leaves. Grows well with low soil moisture and high air humidity.

**Damage**: Leaves are distorted or die, exposing fruit to sunburn.

**Transmission**: Spores spread by wind.

### Prevent mildew

- Plant disease-resistant vegetable varieties.
- Plant in sunny areas.
- Water in the morning so leaves have time to dry.
- Ensure good air circulation.
- Remove infected plant debris at end of season.
- Mulch to prevent spores from spreading when water splashes on the mildew.

### Control mildew

- Horticulture oils (neem).
- Remove diseased leaves.

LESSON PLAN 8

# HARVEST AND POSTHARVEST PRACTICES

| | |
|---|---|
| **What**: This lesson plan shares best practices for harvesting, postharvest handling, curing and/or cooling for selected vegetable crops.<br>**Why**: Nutritious foods, particularly fruit and vegetables, are highly perishable. Use best practices to reduce postharvest losses and ensure food safety.<br>**How**: A series of discussion questions and the sharing of best practices. Illustration of how to use the pot-in-pot cool storage approach. | |
| **Planning**: Gather materials for pot-in-pot demonstrations; make a picking bag using local materials. | **Materials**<br>2 unglazed clay pots, sand and water<br>Fabric to make a picking bag (if it is to be demonstrated) |
| **Timing**: 60-75 minutes | **Video**: Pot-in-Pot Refrigeration |

### Ask

When asking the following questions, seek responses from many participants to understand the different perspectives among community members. Allow men and women to provide responses without judgement. These questions will help you understand the beneficiaries' understanding of postharvest loss.

> **?** **Can you share your experiences of postharvest problems and what you did to reduce them?**

Listen carefully for responses on the type of postharvest problems being experienced. The table below lists 10 types of postharvest losses for your information. It is not necessary to review this table with the participants.

### Ten types of postharvest problems

| **Postharvest problems** | **Description** |
|---|---|
| Water loss (weight loss) | Shriveling or wilting of vegetables |
| Water loss (loss of textural quality) | Softening, limpness, loss of crispiness or juiciness |
| Mechanical damage | Bruises, cuts, surface abrasions or crushing |
| Physical losses | Disease, insect attack |
| Contamination | Soil, pathogenic bacteria (soil-borne disease), pesticide and chemical residues |
| Temperature | Chilling injury, freezing injury, heat injury, sunburn |
| Nutrient imbalances | **Calcium deficiency** Poorly developed stems/roots, new leaves are dull, curled and scorched.<br>**Boron toxicity** Yellowing or browning of foliage. Leaf tips become dry, a gummy substance oozes from the branches or trunk; stunted growth. |
| Atmospheric gases | Damage from ethylene (russet spotting, softening, induced browning) |
| Growth and development after harvest | Rooting; sprouting; shoot development; asparagus elongation/curvature; greening of potatoes; fiber development; loss of color, flavor or firmness |
| Nutritional losses | Loss of stored carbohydrates and vitamin C |

### Show and explain

*Most of the experiences you have had with postharvest loss can be managed or eliminated by using proper harvest and postharvest practices. Even nutritional losses can be reduced with proper postharvest handling and cool storage. After all the effort you have made to grow healthy, delicious, safe and nutritious foods, you don't want to see this food wasted. There are several harvest and postharvest practices to reduce this lost. We will discuss several of them today.*

? **When harvesting your vegetables and fruit, what practices do you use?**

Listen carefully for practices listed below. After hearing from the participants, share information on practices not already mentioned or correct any misunderstandings.

*You have mentioned different practices you have used to reduce losses during harvest, I will share some additional practices with you now.*

## Best practice for harvesting garden vegetables

- Harvest early in the morning when it is cooler.
- When harvesting crops susceptible to fungal diseases (e.g., green beans, peppers), let dew dry off in the morning before you harvest.
- Use sharp, clean tools for harvesting.
- Remove any vegetables that are diseased or damaged, and dispose of them away from the garden site. Do not compost diseased vegetables.
- Handle vegetables gently and never drop, throw or dump them roughly from one container into another as this leads to rapid deterioration and loss of quality and shelf life.
- After harvest, provide shade in the field to help keep the harvested vegetables cool.
- Use a wearable picking bag or harvesting sack to reduce the damage to fresh vegetables during the harvest. Picking bags should be kept clean and washed between uses.


### Wearable picking bags

These harvesting aids can be made by sewing bags with openings at both ends and adding shoulder straps, fitting fabric over a bucket, fitting bags with adjustable harnesses, or by simply adding an open pouch to an apron. Picking bags should be kept clean and washed between uses. *Photo by Lisa Kitinoja for CRS*

After harvesting, store the vegetables to help you reduce waste and to have nutritious food available in the near future.

**? What are some practices you use for storing vegetables?**

Listen carefully for practices listed below. After hearing from the participants, share information on practices not already mentioned or correct any misunderstandings.

*You have mentioned different practices you have used for storing vegetables; I will share some additional practices with you now.*

## Best practice for storing vegetables

- Store only high-quality vegetables.
- Use shade to keep vegetables cool after the harvest.
- Sort and separate damaged and diseased vegetables before storage.
- Store at the proper humidity level.
  - Onions/garlic need to be stored in dry environments with good air circulation.
  - Most other vegetables need to be stored in humid environments.

- Crops stored together should tolerate the same temperature, relative humidity and ethylene level (gas given off by ripened fruit) in the storage environment.
    - Plants with high ethylene are ripe bananas, mangoes and tomatoes.
    - Ethylene-sensitive commodities are leafy greens, cucumbers, carrots, potatoes and sweet potatoes. These plants get an undesirable color, flavor and texture if stored with ripening bananas, mangoes and tomatoes.
- Provide adequate ventilation and air circulation by maintaining space between containers.
- Containers should be strong enough to withstand stacking.

## POT-IN-POT REFRIGERATOR

*Photo courtesy of [wikiHow](). Licenced under [Creative Commons]().*

### How do you store vegetables and fruits after harvest?

Listen carefully for any local practices for cool and dry storage of fruit and vegetables.

*There are several simple storage structures for fresh vegetables and fruit, but I will show you the simplest and least costly for cold home storage. This storage option, the pot-in-pot, works well where the relative humidity is low or in warm/hot climates during the dry season.*

- Diagrams of how to build a pot-in-pot as well as the steps listed below are available at: *How to make a pot in a pot refrigerator*. Wikihow.
- A video on building a pot-in-pot is available at: *Homemade pot-in-pot refrigerator "off grid fridge" cools air up to 40F*.

## How to build pot-in-pot storage

- Obtain two large unglazed clay or terracotta pots. One pot must be smaller than the other. They can be of any shape. The smaller pot must fit inside the larger pot and there should be a space around it of at least 1 to 3 cm (0.4 in. to 1.2 in.).
- Fill in any holes at the base of the pots using clay, large pebbles, cork, a homemade paste, putty or duct tape. If you leave the holes open, it will not stay cool.
- Fill the base of the larger pot with coarse sand to about 2.5 cm (1 in.) deep, and only fill to a height that will ensure the top of the smaller pot sits at an even height with the larger pot.
- Place the small clay pot into the large pot. Arrange its base flat on top of the lower layer of sand.

- Fill all around the small pot with sand. Fill it almost all the way, but leave a small gap at the top.
- Pour water over the sand. Do this until the sand is completely soaked and unable to take any more water. Give the water time to soak into the terracotta.
- Take a cloth, towel, wet hessian (jute, burlap) or similar fabric and dip it into water. Place it over the top of the inner pot so that it covers it completely.
- Allow the inner pot to cool down. Test the temperature with your hands.
- Store the pot-in-pot in a dry, ventilated space for the water to evaporate effectively.
- Place vegetables or other items inside the inner pot for storage. Check the dampness of the sand regularly. Add more water as it becomes drier to keep it well moistened. Usually this will need to be done twice a day.

*Throughout our lessons on gardening, we have discussed practices and methods to ensure that the food we produce and harvest in our gardens is safe for our families to eat. Let's briefly review them.*

**Four food safety principles**: *Clean soil, clean water, clean surfaces and clean hands.*

**? What are some ways we can ensure we have clean soil?**

- Compost manure completely to kill germs; incorporate it into the soil at least 2 weeks before planting.
- Keep domestic and wild animals out of gardens to reduce the risk of fecal contamination.
- Prevent run-off or drift from animal operations from entering the garden.

**What are some ways we can ensure we have clean water?**

- Keep livestock and chemicals away from the active recharge area for well water that will be used for irrigation.
- Apply irrigation water to soil around plants, rather than to foliage or fruit.
- Use integrated pest management practices to minimize chemical pesticide use.

**How can we ensure we have clean surfaces?**

- Wash and sanitize tools and field containers before each use. You can wash with soap, rinse with clean water and air dry.

**How can we ensure we have clean hands?**

- Workers who harvest produce must wash their hands after using the toilet or changing a dirty diaper/nappy.

**What postharvest practices would you like to try this garden season? What might stop you from trying these practices?**

Listen for any technical support or coordination efforts the project can provide. Listen for any gender issues related to access to and control over resources, workload and decision-making power over using practices.

Thank the participants for their active participation.

## ANNEX 6

# POSTHARVEST PROBLEMS AND MATURITY SIGNS

| Crop | Top three postharvest loss problems | Maturity index |
|---|---|---|
| Cabbage | Water loss (wilting), loss of green color (yellowing), mechanical injuries | Head compact, firm or solid, can be of different sizes |
| Kale | Water loss (wilting), loss of green color (yellowing), mechanical injuries | Can harvest smaller or larger leaves. If flowering, then overmature. |
| Orange-fleshed sweet potato | Physical injury (cut) during harvest, softening, rotting, water loss | Tops beginning to dry out and topple down |
| Tomatoes | Bruising, over-ripeness and excessive softening, water loss | Seeds easily move around when mature green fruit is cut, or green skin color turning pink |
| Green hot pepper (*karia*) | Overmaturity at harvest (change of color), water loss (shriveling, bruising) and other mechanical injuries | Full size (size depends on the variety) |
| Onions | Mechanical injuries (bruises, cuts, crushing); improper curing; sprouting or rooting | Tops beginning to dry out and topple down |
| Garlic | Shrivelling and softening; mechanical injuries (bruises, cuts, crushing); improper curing | Tops beginning to dry out and topple down |
| Beetroot | Mechanical injuries (bruises, cuts, crushing); improper curing; sprouting or rooting | Greens should be no larger than 15 cm (6 in.)<br>Roots can be harvested any time |
| Pumpkin | Overmaturity at harvest, water loss, mechanical injuries | Dull rind that a finger nail cannot cut into; brown stem |
| Swiss chard | Water loss (wilting), loss of green color (yellowing), mechanical injuries | Harvest young when shorter than 10 cm (4 in.) long or at maturity |

# ANNEX 7

# CURING ONIONS AND GARLIC

If the community members are growing onions and garlic, provide the information below.

## Curing practices

- Curing is simple and low cost.
- It reduces decay, water loss and weight loss.
- There is a curing practice for bulb crops, such as onions and garlic, and a curing practice for root/tuber crops.

## Onions and garlic

- Curing directly after the harvest enables the external layers of skin and neck tissue to dry out prior to handling and storage.
- If not raining, the crops can be under-cut[3] in the field, windrowed (piled in a row) and left to dry naturally for five to ten days. The dried tops can be arranged to cover and shade the bulbs during the curing process, protecting the produce from excess heat and sunburn.
- If the weather is humid or it is the rainy season, the crop can be removed from the field after harvest and dried under a simple tarpaulin or shed cover. The dried layers of "skin" then protect the produce from further water loss during home storage or marketing.

Onion showing a tight, closed, dry neck after curing is complete. *Photo by Lisa Kitinoja for CRS*

## Curing roots and tuber crops

- Curing roots and tuber crops (sweet potatoes) will heal wounds.
- To cure, place the crop in a small pile in the field.
- Cover it with dry plant materials (straw or dried leaves) and then with a large cloth (made of burlap or jute, never plastic).
- Leave them under the cover for four to seven days. The temperature outside should be 30°C to 32°C (86 to 90°F).

3. When the part of the onion that remains beneath the soil is raised above the soil surface.

FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative

FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative

www.feedthefuture.gov