

# Forest Garden Facilitator's Guide

English - Anglais



**TREES  
FOR THE  
FUTURE**



**Forest Garden  
Training Center**

## Acknowledgments

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## Introduction

Trees for the Future is dedicated to ending extreme hunger and poverty across Sub-Saharan Africa by revitalizing degraded lands using the Forest Garden Approach. The Forest Garden Approach, developed by Trees for the Future, diversifies farming systems with trees and food crops that meet subsistence needs and market opportunities. While conventional agriculture programs focus on one or few crops, the Forest Garden Approach is rooted in diversifying each farm with many food crops and thousands of trees so farming families will be self-sufficient in their production of food, timber and non-timber forest products.

### **What is the Facilitator's Guide?**

The Facilitator's Guide is designed for use in conjunction with the Technical Manual and Farmer's Workbook to provide both facilitators and farmers with the resources and guidance needed to pursue the Forest Garden Approach within a four-year curriculum.

### **Who should use the Facilitator's Guide?**

Trainers, extension workers, specialists, and individuals interested in working with farmers to implement agroforestry techniques that increase both their income and food security in a restorative way.

### **Why should this Facilitator's Guide be used?**

By guiding massive numbers of subsistence farmers through the phases of protecting, diversifying and optimizing their farms, we can have a permanent impact on the lives of millions of smallholder farming families across the developing tropics struggling to survive on their degraded farms.

### **How should this Facilitator's Guide be used?**

The training modules in this Facilitator's Guide were designed to guide farmers through the three phases of the Forest Garden Approach. In the first year, the focus is largely on growing and planting trees that protect the land. Farmers learn to design Green Walls and plant thousands of agroforestry trees around and across their field to serve many purposes. By the second year, farmers undergo training in vegetable and fruit tree production to diversify the sources of income and nutrition. By the third and fourth years, farmers learn to optimize their field by using techniques that maximize productivity on the land in a sustainable way.



Each module in this Facilitator's Guide has a corresponding Farmer's Workbook section for farmers to keep records, take home activities and illustrations that will help them recall what they learned and need to do when returning home after workshops. This Facilitator's Guide is also accompanied by the Forest Garden Technical Manual. Each module in this guide refers to the relevant chapters within the manual and provides all the technical answers behind many of the questions asked in the facilitation exercises.

**Please note** that you will encounter annual planning and monitoring activities that Trees for the Future (TREES) uses but which may not be applicable to all communities or projects. We have labeled these as (optional for non-TREES projects).

We look forward to hearing how this resource has helped you and how we can improve it.

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## Mobilization Meeting Facilitator's Guide

The purpose of this document is to guide facilitators through the mobilization meeting discussion. It is important that facilitators are thoroughly familiar with this document going into the meeting and that they cover all of the main points, though it can be presented in the facilitators' own words.

Throughout the document there are prompts to use a 'visual tool', which refer to the posters that should be shown during these sections to help farmers visualize the discussion points.

### Mobilization Meeting Purpose

The purpose of this meeting today is to talk about TREES Forest Garden Program. It is a multi-year agriculture program that can help you produce more nutritious foods and forest products to eat and sell.

But first, I have a couple of questions:

Ask: What do you think is the most important job in the world?

Answer: At TREES, we know the answer is farming. You have the most important job in the world, because we cannot live without the food you produce. You play a part in feeding the world, and we cannot survive without farmers like you.

Ask: If farming is the most important job, what is the most important asset? What does everyone in the world want?

Answer: Land. Without land, you can't produce food.

Just like you, there are hundreds of millions of other farmers around the world, trying to farm on increasingly degraded land. They see their yields decreasing; the health of their land, forests, soil, and water in decline; the weather patterns more unpredictable than ever; the costs of farming increasing while income remains low.

Forest Gardens help to reverse many of the problems that farmers face. Through this program TREES will teach you on how to get the most productivity and the most money from your land.

### Who is Trees for the Future?

Trees for the Future (TREES) is an international development organization founded in 1989 by Dave Deppner, a chicken farmer from the U.S. who served as a Peace Corps Volunteer in the Philippines in the 1970s. While there, he witnessed the environmental degradation and poverty brought on by illegal logging and the cutting down of forests for monoculture crops that relied heavily on synthetic fertilizers and pesticides. Those practices were destroying the land, and with it, people's livelihoods. Dave worked with local community leaders to give farmers tree



seeds and training, and to help them plant trees that would revitalize their land and give them hope.

Over the last 30 years we have learned that farmers can grow more crops and make more money if you are not starting over each year, but building the field up in layers. These layers maximize land productivity through diverse types of trees and crops that provide for families' many needs - food, income, and household products. One of the principles that TREES has always followed is to only promote technologies that are within reach of even the poorest of farmers, that they are low- or no-cost, and that any farmer, anywhere, can learn to use them on their own land. TREES has been doing this successfully for over 30 years now, having helped farmers in 60 countries to plant more than 200 million trees. By joining this program, you are joining a network of farmers around the world who are improving their lives and lands by growing Forest Gardens.

## TREES' Forest Garden Approach

Facilitator Notes: Use the Mobilization posters and the language below to explain the Forest Garden in your own words.

### What is a Forest Garden

**Visual tool:** Use the picture and drawing on the title poster to explain a Forest Garden and layers

A Forest Garden is a multi-layer agricultural system that allows farmers to produce numerous products on one piece of land, including vegetables, fruit, timber, fuelwood, livestock, and more. Forest Gardens are made up of different components that allow you to maximize the production of your land. **They reduce your risk** through diversifying production, growing more perennials, and by making your land more resilient to drought, floods, and pests. **They reduce your costs** by reducing the need for expensive inputs like fertilizer, pesticides, and seeds. Forest Gardens provide an abundance of products to eat and sell throughout the year.

### The Forest Garden Program

The Forest Garden Program is a multi-year approach consisting of half-day in-field training events, hands-on skill-building, and dedicated technicians for agriculture extension that helps you organize into groups, train together, transform your fields into Forest Gardens, and work collectively to increase market access and profit.

### What You Give to the Program

**Visual tool:** 'What you Give to the Program' poster

Farmers in the program will be expected to:



- Use your land, water, and labor to establish your own forest garden. The forest garden is yours, however. You choose what you want to grow, and how to use what you grow.
- Actively participate in four to five training events per year over the three to four-year project
- Practice and refine the skills you learn while establishing your forest garden

In order to participate:

- Farmers must have secured, long-term tenure of the site they will convert into a Forest Garden
- The family's Forest Garden site must be at least ½ hectare (roughly 1 acre) in size
- The site must be within one kilometer from the family's home
- The site must be no more than one kilometer from a year-round water source
- The site must not currently have more than 20% coverage of trees or perennials (coffee or tea, for example)
- The site has previously been used for agriculture (natural habitat/forest should not be cleared for the Forest Garden)

It is important to be clear from the start that **you do not receive money or incentives** to participate in the project.

## What You Get from The Program

**Visual tool:** 'What you get from the program' poster

TREES provides the basic inputs required for farmers to establish their forest gardens. These include:

1. Knowledge and skills training
2. On-site assessment and mentoring
3. Agroforestry tree seeds
4. Fruit tree seeds and seedlings
5. Timber tree seeds
6. Nursery tree sacks
7. Vegetable seeds for your permagarden
8. Nursery and planting tools (e.g. watering can, shovel, wheelbarrow, pruning shears)
9. New market linkages and opportunities
10. Upon graduation, a Forest Garden Completion Certificate, endorsed by the United Nations

## What You Do in The Program

**Visual tool:** 'What you do in the program' poster

The Forest Garden Approach generally follows three overlapping phases:



### ***Protection: Years 1 to 2***

You will plant a protective living fence around your site to prevent soil erosion and begin building your soil. You will also plant a permagarden and fruit trees to begin diversifying your production for fast-growing, nutritious products to eat and sell.

You will learn to:

1. **Plan and create your own Forest Garden design** that you will use as a map to guide the establishment of your Forest Garden
2. **Produce compost** to provide a year-round source of free, nutrient-rich, soil-building fertilizer
3. **Establish and manage a tree nursery** to raise agroforestry tree (fast-growing trees for fertilizer, fodder and protection) and fruit trees
4. **Plant a green wall/living fence and alleys** made up of fast-growing trees, that surround your forest garden, protect it from wind, erosion, and intruding animals, and improve soil fertility
5. **Plant and care for fruit trees** identified for production of nutritious fruit to eat and sell
6. **Establish a permagarden** where you will identify and grow diverse, nutritious, and marketable vegetables to eat and sell, using sustainable water and fertility management practices

### ***Diversify: Years 2 and 3***

As your living fence secures your Forest Garden, you can safely diversify what you grow. You will add to your fruit tree portfolio. You will enhance your permagarden to produce nutritious and marketable food throughout the year, stabilizing income and building resilience. You will learn to harvest and save your own vegetable and tree seeds. You will better conserve and manage your water and soil. You will have increasingly valuable assets year-to-year rather than always starting from the beginning of the planting process each year.

You will learn to:

1. **Review your Forest Garden design** and update it to reflect learning and to ensure help you better utilize the horizontal and vertical space in your forest garden as well as the timing of production and harvests throughout the year
2. **Manage your trees** to maximize the production and timing of tree products (e.g. fuelwood, posts, fodder) and services (fertilizer and mulch, shade and sunlight, and protection)
3. **Graft trees** using basic techniques to produce high-value trees
4. **Control pests** using integrated pest management (IPM) practices instead of expensive and dangerous pesticides
5. **Manage water** through capture and storage to enhance soil moisture and water availability, enabling improved production and extending the growing season



6. **Seed saving** to allow you to build a supply of diverse, high-quality seeds to plant or trade year after year
7. **Choose elective training** from a variety of advanced forest garden topics, including livestock integration, advanced grafting, and more

### ***Optimize: Years 3 to 4***

You will learn to optimize the use of space, soil, water, sunlight, and time on your farm. Engaging in group activities will offer learning opportunities, improve access to profitable markets, and provide savings and credit opportunities. Leaders of your group will collaborate with other groups and market actors in your area so that benefits from your forest gardens will continue to grow. You will also begin to organize, aggregate and commercialize your products while accessing important services required to produce and market your products.

You will learn:

1. **To improve marketability and to engage in group enterprise.** You will learn practices for harvest, postharvest, and value addition for your core products. With your producer group you will learn ways to increase savings and profit, access new markets, and reduce risk.
2. **Business and Leadership (for Lead Farmers only)** where group leadership will learn critical management and enterprise skills to build the capacity and expand opportunities of your group.
3. **To participate in Savings and Lending clubs** to help you manage your finances, provide opportunities for small loans, and build your wealth.
4. **Group Enterprise Development** where your group will further develop skills and apply them to expand market opportunities, reduce marketing costs, increase profit, and mitigate risk.
5. **To Plant-it-Forward** by developing a plan with your group for a tree-planting project that benefits your community and environment.
6. **To Develop a Sustainability Plan** to ensure you and your group is able to continue building your forest gardens and enterprises after the project phases out

## **What You Can Produce in The Program**

**Visual tool:** 'What you can produce in the program' poster

*Facilitator's Notes:* Using the poster as a guide, the facilitator can ask participants what they could potentially produce in their forest garden. Encourage them to mention products that are on the poster, as well as those they could produce that are not on the poster.

## **The End Result**

**Visual tool:** 'Graduation' poster



By the end of the program, participants will receive a graduation certificate endorsed by the United Nations and

1. Have a thriving Forest Garden where you will continue to grow and mature, sustainably producing a diverse assortment of food and forest products to eat and sell throughout the year, every year.
2. Be able to work with your group to aggregate input purchases, services, and marketing with other farmers to expand market opportunities, reduce costs and increase profit.
3. Improve financial management and access to money through savings & lending groups.

Ultimately, Forest Garden Program Graduates will have significantly increased household nutrition and income while at the same time restoring and sustaining your land and natural resources.

## Q&A

Now the facilitators can give participants a chance to ask questions about the program.

## Lead Farmer Selection

The final thing to note before the farmers depart is that each group will select a Lead Farmer to assist the technicians and farmers throughout the project. The Lead Farmer should be a well-respected, motivated, trustworthy, innovative, and experienced farmers who will have the following responsibilities:

- Support and liaise between TREES' technicians and participant farmers within each farmer group.
- Attend all community and training events and meetings.
- Host and assist with training events at their sites as needed.
- Visit participants' Forest Gardens regularly to deliver planting materials and equipment, and to monitor their sites and offer technical guidance.

Lead Farmers are generally selected by group members, with support from technicians where needed, after the first training event. Groups should start thinking about who in their group would serve this role best.

## Forest Garden Planning

### Description

This workshop opens the Forest Garden program by leading farmers through activities for planning what diverse crops they will grow at the family and group level to improve nutrition, increase income and meet other household needs in the year and years to come. The crops they select will provide resilience and multiple harvests at different times of the year, reducing the risk of crop loss and food shortage. The activities in this module will help farmers pick the best crops and trees to meet their needs and market opportunities going into the Forest Garden Design module.

### Learning Objectives

By the end of this module, farmers will be ready to design their Forest Gardens by learning how to:

1. Identify environmental trends that impact them
2. Develop a calendar to help plan their Forest Garden designs
3. Identify fruit trees, vegetables and non-food products for nutrition, for market, and to alleviate the lean season
4. Prioritize marketable products and assess prices and strategies to increase profit
5. Measure their field border and sketch a top view map for the following workshop.

### Venue and Timing

The workshop is the first workshop, creating the foundation for the Forest Garden Design. early enough to allow sufficient time for planning before the primary growing season. This workshop is followed by the Forest Garden Design module.

### Relevant Technical Manual Chapters

Before this training event, the facilitator should read and thoroughly understand the following chapter in the Technical Manual:

- Chapter 1: Introduction to the Forest Garden

### Preparation

- Invite the lead farmer's family to the workshop and explain the importance of their participation in the workshop.
- Prepare flipcharts with calendar templates. At the top of the flipchart paper, write the **months**. Below the months, draw a line for **Holidays** and another for **Seasons and Weather**.

### Supplies

- Ballpoint pens
- Flip Chart paper
- 2x Seasonal calendar template posters (can be pre-written on flipchart paper)
- Tape and movable items for calendar OR sticky notes



- Markers (multiple colors)
- Tape measure for pacing activity
- 100 m string for pacing activity
- Example Forest Garden Design as a preview for what is coming in following workshop

## Total Time

Approximately 3 hours and 45 minutes

## Handouts in Farmer's Workbook

- Nutritional rainbow chart of local vegetables and fruits
- Crop selection for Forest Garden Planning



## Forest Garden Planning

### Summary of Activities

#### **Activity 1: Environmental Trends and Solutions (30 Minutes)**

- Environmental Trends

#### **Activity 2: Planning Calendar (2 hours)**

- Getting started
- Fill in the seasons
- Fruit trees for the home and for sale
- Vegetables for a full nutrition diet
- Market planning
- Lean season
- Discussion

#### **Activity 3: Market Analysis (45 minutes)**

- Mark holidays and festivals
- Identify most promising market products
- Price analysis of prioritized products
- Discussion

#### **Activity 4: Take Home Activity Review (30 minutes)**

- Household conversations to confirm plans
- Fill in Farmer's Workbook
- Start Top View Maps



Welcome! Today you begin planning to grow your Forest Garden. The diversity of crops you will grow will provide resilience and multiple harvests at different times of the year. The diversity will also provide you much of the food, fodder, livestock feed, fuelwood and other products that you need and can sell. Today we will do activities to determine the best trees and crops that will meet your needs and opportunities.

**RULES:** Make sure everyone introduces themselves each time they speak so the group can build familiarity and learn everyone's name.

## Activity 1: Environmental Trends and Solutions (30 minutes)

### STEP 1: Environmental Trends

Farmers are very aware of the environment around them, and how things like floods, drought, wind, or pests affect their land and production. Ask farmers the following questions to identify trends, and capture the common ones on a flipchart. Farmers are very comfortable talking about the weather, the local environment, and the challenges with farming, so get them active in a conversation about the major seasons in their area. Try to obtain a group level of agreement on the climatic, weather, and environmental trends that impact agriculture. Use the following questions to solicit discussion from the group. While discussing the questions, write the common trends the group comes up with on a flipchart (see Table 1).

#### Precipitation:

- When do rains usually begin and end? Main rains? Short rains? Has this always been the case?
- When are the best times to plant gardens?
- When are the best times to plant trees?
- What trends have they seen with precipitation?
- Is there flooding? Drought? Variability?

#### Storms:

- What trends have they seen with storms and how can farmers adapt?
- Do they have any observation on the frequency of storms? Rain storms? Dust storms? Hurricanes or typhoons? Which directions do the worst storms come from?

Environmental Trends
▪ Temperatures increasing in dry season
▪ Rain is unreliable and starts at different times
▪ We get rain in the offseason now
▪ Damaging storms are common in rainy season
▪ Soil is less fertile than before
▪ We have drought every three years
▪ Well water is unreliable
▪ Harder to find firewood

**Temperature:**

- What trends have the seen with temperatures and how can farmers adapt?
- Are temperatures getting hotter? Are temperature extremes (hot and cold) sporadic?

**Water quality and availability:**

- How are local water resources changing? Is ground water level changing? Is there a noticeable difference in the local stream or river?

**Forest cover and topsoil:**

- How is deforestation and the loss of topsoil impacting farms and families in the area?
- Is soil fertility changing? How?

**Pests:**

- Have there been changes to the pests that attack agriculture in the last five to ten years? How?

**STEP 2: How can trees help?**

Review the list of environmental trends and discuss with farmers the many ways that trees in Forest Gardens will address these needs. Discuss which types of trees or species are helpful for each point.

- How can trees minimize wind damage to fields?
- How can they protect your field?
- What do they do for ground water?
- What do trees do for soil health?
- What do trees do for erosion?
- What uses are there for tree leaves? stems? sticks? branches?
- How can trees be planted and used to combat pests?
- What do tree roots do to the soil?
- Are certain trees better for soil than others?
- Why are leguminous trees particularly helpful?
- Which trees produce berries? nuts? fruit? medicine? timber?
- How else can trees help us or our environment, feed us, or provide us with things to sell?

## Activity 2: Planning Calendar (90 Minutes)

Seasonal calendars are a planning tool that will help you think through various elements of a forest garden and how they are impacted by or can change based on the time of year. This exercise helps you plan your Forest Garden to ensure you have nutritious foods and forest products to eat, use, and sell throughout the entire year.













### STEP 1: Getting started

Divide the farmers into small groups of five and provide each group with a flip chart and marker. Instruct each group to recreate the chart below with months across the top.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

### STEP 2: Fill in the seasons

Instruct the small groups to draw rain clouds and sun to depict dry and rainy seasons in their zone. They may also mark the optimal time(s) to plant trees.













1. Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Season												

### STEP 3: Fruit trees for home and for sale

Brainstorm with farmers, month by month, the seasonality of fruit so that they can list the fruit trees that bear fruit each month on their flipcharts. Be sure to list those that earn the most income, as well as those that grow in the lean season, when little else grows.













With the full group, ensure participants understand that farmers often focus on two or three trees to plant in larger numbers for market. As these trees are a long term investment and take up quite a bit of space, it is important that participants think carefully about this decision before you pursue planting them. As a full group, lead them through an activity of listing and ranking the fruit trees that are perceived to have the highest ease of planting and return. Once you have the top 3, circle them on the calendars and write them in your Farmer Workbooks. Each farmer should take this list home (along with others you may be more interested in) and discuss it with your family, or with neighbors, friends, or at markets. It is important to be confident in your decision before you invest the time and space within your Forest Garden to plant them.

At this time, the Facilitator should also share the types and numbers of grafted trees that TREES will provide to farmers in the program so that farmers may think about where they might source the others.

1. Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2. Season												
3. Fruit trees	Lemon Orange Passion Papaya	Lemon Orange Passion Papaya	Guava Jackfruit Avocado	Guava Jackfruit Avocado	Guava	Guava	Guava Mango Loquat Avocado	Guava Mango Loquat Avocado	Guava Loquat Custard apple	Guava	Papaya Guava Mango	Lemon Orange Passion Papaya Guava Mango Chocolate berry

#### STEP 4: Vegetables for a full nutrition diet













Begin this exercise by drawing a box around the months where farmers can garden. There should be two boxes in places where there are two gardening seasons. Plan to grow a variety of crops that contribute to a full nutrition diet in both the rainy and dry seasons, if possible. Use the lists of crops provided to ensure the most important color categories are represented. Ensure that they include orange/dark yellow, dark green, and protein, given the importance of the nutrients in these types. Then they should fill in other colors, emphasizing that the darker the color, the more nutritious.

1. Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2. Season												
3. Fruit trees	Lemon Orange Passion Papaya	Lemon Orange Passion Papaya	Guava Jackfruit Avocado	Guava Jackfruit Avocado	Guava	Guava	Guava Mango Loquat Avocado	Guava Mango Loquat Avocado	Guava Loquat Custard apple	Guava	Papaya Guava Mango	Lemon Orange Passion Papaya Guava Mango Chocolate berry
4. Vegetables for Nutrition						INCLUDE: Orange, Dark green, Protein Red, Green, White, Purple						

#### STEP 5: Market planning

In this step we identify the farmers' perceived market opportunities for the main market gardening seasons. Ask each small group to draw a box on the market planning line around the months when market gardening is possible, whether rainfed or irrigated. There will be two boxes in places with two gardening seasons.

In addition to selling fruit tree-based products, farmers will also develop plans for selling vegetables and a variety of other timber and non-timber forest products. In this section, the planning activities will focus on market gardening, but the facilitator should help the farmers entertain other Forest Garden products (berries, non-edible products, chickens/eggs, milk, dried fruit, juices, animal feed, aloe vera, etc.) that are popular locally.













1. Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2. Season												
3. Fruit trees	Lemon Orange Passion Papaya	Lemon Orange Passion Papaya	Guava Jackfruit Avocado	Guava Jackfruit Avocado	Guava	Guava	Guava Mango Loquat Avocado	Guava Mango Loquat Avocado	Guava Loquat Custard apple	Guava	Papaya Guava Mango	Lemon Orange Passion Papaya Guava Mango Chocolate berry
4. Vegetables for Nutrition						INCLUDE: Orange, Dark green, Protein Red, Green, White, Purple				INCLUDE: Orange, Dark green, Protein Red, Green, White, Purple		
5. Vegetables for Market						Hot pepper, eggplant, okra				Onion, Lettuce, Carrot		

## STEP 6: Lean Season

Ask each small group to draw a box around the months they consider the 'lean season', when food is generally the hardest to find. Brainstorm what additional sales of crops, products, NTFPs, timber, or livestock that should be considered during the lean times when there may be no rain.

- During which months are you likely to not have enough food to eat? Draw a box around those months.
- What types of crops, livestock or livestock products, timber, or non-timber tree products could the members of the group make the most money from during the lean season using the resources we have?
  - Look at the fruit trees you listed in the calendar. Which are producing in the lean season? Which would sell the best?
  - Can we dry or store crops in other seasons to have products to sell when we need it? Is there a crop byproduct we can sell as fiber (maize leaves), fencing (sorghum stalks), compost or livestock feed?
  - Are there opportunities with livestock, poultry or beekeeping in the lean season?
  - What are the top few timber species you are interested in growing? Avoid planting eucalyptus and pine in your field.
  - Think about your household needs and products you purchase, or would like to purchase (fuel wood, fertilizer/compost, medicines, insecticides, timber/posts, tools, etc). You can produce these in your forest garden and sell it to others too.

- What other non-timber Forest Garden products can you sell in the next lean season? These may vary from uses of the wood, leaves, seeds, gums, dyes, saps, crafts, oils, cosmetics, etc. This includes packaging livestock feed for animals,

1. Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2. Season												
3. Fruit trees	Lemon Orange Passion Papaya	Lemon Orange Passion Papaya	Guava Jackfruit Avocado	Guava Jackfruit Avocado	Guava	Guava	Guava Mango Loquat Avocado	Guava Mango Loquat Avocado	Guava Loquat Custard apple	Guava	Papaya Guava Mango	Lemon Orange Passion Papaya Guava Mango Chocolate berry
4. Vegetables for Nutrition						INCLUDE: Orange, Dark green, Protein Red, Green, White, Purple				INCLUDE: Orange, Dark green, Protein Red, Green, White, Purple		
5. Vegetables for Market						Hot pepper, eggplant, okra				Onion, Lettuce, Carrot		
6. Lean Season					Guava, Dried jackfruit, Leaves for livestock feed, Gmelina timber, Roselle							

### Discussion:

Before closing this activity, give participants the chance to review their calendars. Ask them to look at others' calendars over the break. Ask the following questions and give them a few minutes to respond and to ask questions of their own.

- Does this plan ensure your families will have nutritious foods to eat throughout the year?
- Does it ensure you will have opportunities to earn income from various products throughout the entire year?
- How does this Forest Garden calendar/plan differ from your current production?

## Activity 3: Market Analysis Calendar (45 minutes)

Small groups will use a second seasonal calendar to identify products they can focus on for marketing and to analyze their profitability. After each small group comes up with its top few perceived opportunities, have each small group share with the larger

group to find some group agreement. They will then discuss good planning and production practices to reduce costs and increase profits.

### STEP 1: Mark holidays and festivals

Draw a second calendar on another piece of flipchart paper, using the same template as before. Fill in the twelve months. In the first line, ask each group to mark the times of year that major holidays and religious festivals occur

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>1. Holidays &amp; Festivals</b>				Ramadan	Easter		Eid al Adha					Christmas

### STEP 2: Identifying most promising market products

Now ask the groups to brainstorm a list of products that they think have the most promising market potential. Be sure they look at the circled trees, vegetables for market, and lean season crops identified in the planning calendar activity. Ask the questions below:

- Which crops are in demand seasonally?
- Which crops are most popular around holidays?
- Which crops are favored by traders, processors and retailers in our zone?
- What other opportunities exist with markets, grocery stores, public institutions (prisons, schools) or tourism?
- What products can be stored safely or can be left and harvested when prices are high?
- What products are less affected by environmental hazards (drought, floods, pests, etc)?
- What type of processing or transformation might we want to consider, such as drying, juicing, bagging, or milling?
- What timber and non-timber forest products might be promising?
- Be sure to consider if the group has experience producing selected products, or if there are high labor or input demands as these may increase the costs of production or startup.

After the groups have had time to brainstorm a list, have them prioritize the products they perceive to have the highest potential for income, and list them in the table.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>1. Holidays &amp; Festivals</b>				Ramadan	Easter		Eid al Adha					Christmas
Product 1: Avocado												
Product 2: Carrot												
Product 3: Onion												
Product 4: Papaya												
Product 5: Livestock feed												

### STEP 3: Price Analysis of prioritized products

Ask the groups to analyze each of the prioritized products according to price fluctuations throughout the year. It is useful to identify the best and worst months for each crop, then fill in the gaps. The facilitator may use smile or frown face symbols (or another one that works for farmers) to represent prices at market when they are high or low.

- When during the year is the price the highest? Why?
- When is the price the lowest? Why?
- Is there any way to get your product to market to coincide with the higher price periods? (off season production, season extension, storage, value addition).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>1. Holidays &amp; Festivals</b>				Ramadan	Easter		Eid al Adha					Christmas
Product 1: Avocado			😊	😊	😞	😊	😊	😞	😊	😊	😊	😞
Product 2: Carrot	😊	😊	😊			😊	😞	😞	😊	😊	😞	😞
Product 3: Onion	😞	😞		😊	😊		😞	😞	😞	😞	😞	😊
Product 4: Papaya	😊	😊	😊	😊	😞	😞	😊	😞	😞	😊	😊	😊
Product 5: Livestock feed	😞	😊	😊	😞	😞	😊	😊	😞	😞	😊	😊	😊



## Discussion

End this activity with a discussion on how farmers can use good planning and production practices to reduce costs and increase profits. It is also good to get farmers thinking about why and how to work together as a group, in preparation for upcoming group coordination, production, and marketing activities.

- When during the year is the price the highest? When is the price the lowest? Why?
- Is there any way to get your product to market to coincide with the higher price periods? (off season production, season extension, storage, value addition).
- Let's look at a vegetable that you prioritized: In order to sell it when prices are the highest, when does it have to be planted?
- When are holidays? How does that relate to prices? How might you be able to plan for production to take advantage of that connection?
- When is the lean season? Are there any promising crops that might be harvested and sold during that period?
- Is there any other way to get higher prices? (selling in aggregate as a group to a larger buyer)
- What are some ways to reduce costs? (bulking input purchases with your group; bulk transport to market; identifying increased production efficiencies)
- Which marketable products would we want to consider selling as a group?

## Activity 4: Take Home Activity Review

The facilitator reviews their take home assignments that will help them prepare for the following workshop.

### 1. Household conversations to confirm plans

Through the activities today, we have identified different lists of crops that you are planning to grow in your Forest Garden. There were many assumptions and decisions we had today in our brainstorming. It is important that everyone goes home and talks with their spouses and families about the types of trees and products discussed today. Questions each farmer should discuss with his/her spouse and other decisionmakers in the household:

- Explain the set of fruit trees identified that could make nutritious and lucrative fruit available to the family throughout the year. Does the family have any additional ideas regarding fruit trees that can be grown?
- Explain the vegetables discussed, that can be grown for nutrition as well as for market opportunities with the wider group. Do they have any advice or preference on fruit or crop selection?
- Explain the various products identified as being beneficial during the lean season. Does the family have any additional ideas on things the family can produce during the lean season?

Come prepared at the next workshop to discuss what you learned and how your plans will change based on feedback from the family.

## 2. Fill in Farmers Workbook

Before leaving the workshop, each participant should copy the seasonal calendar from their groups' flipcharts to their Farmer's Workbook. If they have trouble writing, they can ask others for help.

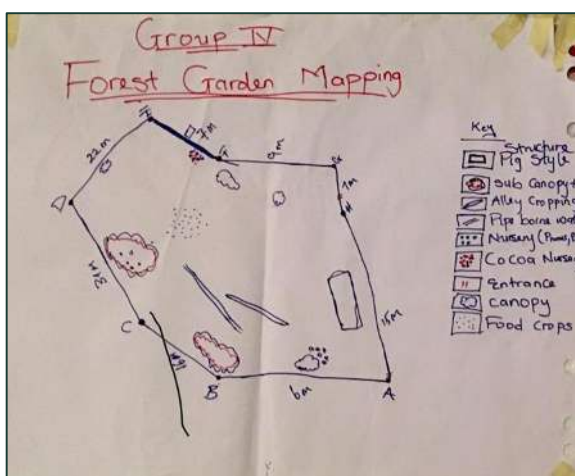
After discussing the workshop and products with your family, fill in (or have someone in your family help you fill in) the following information in your Farmer's Workbook. Note that this should be based on your family's priorities and does not necessarily have to follow what your group selected in the workshop. Also, it is fine to have the same product in more than one category.

- Fruit trees to grow for home and for market
- Vegetables for nutrition
- Vegetables for market
- Products for lean season
- Most promising market products

## 3. Start top view maps

Next workshop, we will create a Forest Garden design that incorporates the trees and crops you want to grow. It looks like the example we have here today. It is important that everyone gather some specific information about your field in order to create a proper design during the next workshop.

- Shape of the field with Perimeter Border
- Orientation
- Highest/lowest points
- Current locations of existing trees, structures or other important features.



I will demonstrate how to do this. Before I draw, I should walk the border and either use a measuring tape or count the number of steps (one step equals one meter) to estimate the lengths of the sides of the field. Give a demonstration of how to do pacing for recording a field border.

- How do you measure a field border by pacing?
- What are some ways to draw field borders when they are different angles?

You may draw your field's border in your Farmer Workbook and record these other important pieces of information there.

## Forest Garden Design

### Goal

Farmers will use the list of nutritionally and economically important trees, fruits, and crops generated in the Forest Garden Planning workshop to create a design of their Forest Garden, arranging species according to the main Forest Garden elements and principles. They will create a Forest Garden Design of their own field, which will serve as a draft blueprint when developing their Forest Gardens over the course of the project, reviewing and revising them as needed each workshop.

### Learning Objectives

By the end of this module, farmers will be able to...

1. Understand the structure and layout of Forest Gardens, primary components and layers, arrangement, services, and uses of different trees.
2. Design a Forest Garden using a step by step process of integrating each of the primary components and trees.
3. Understand how the Forest Garden responds to and integrates healthy management of soil fertility, pests, and water.

### Venue and Timing

This workshop will be held after the Forest Garden Planning workshop, about five months before the rainy season.

### Relevant Technical Manual Chapters

Before this training event, the facilitator should read, review, and thoroughly understand the following chapters in the Technical Manual:

- Chapter 1: Introduction to the Forest Garden
- Chapter 2: The Forest Garden Approach

### Preparation

- To ensure the training goes smoothly in the allotted time, meet with the lead farmer where the training site is located and ask him/her to show you where they would like to have a Forest Garden.
- Collect or identify 4 or 5 flat clean surfaces (sheet of wood, tables, wall) to use for drawing designs.
- Finalize and prepare list of vegetable and tree seeds and seedlings that TREES will provide to farmers. Farmers will write this in their Farmers Workbooks.



## Supplies

- ☐ Roll of flipchart paper OR A3 manila paper (half a flipchart size), 2 per small group
- ☐ Tape
- ☐ 5 large clipboards
- ☐ Pencils, one for each farmer
- ☐ 5 pencil erasers, one for each small group
- ☐ 1-2 pencil sharpeners
- ☐ 5 colored markers, one of each color per small group

## Total Time

Approximately 3.5 hours

## Handouts in Farmer Workbook

- Forest Garden Design: Top View Map



## Forest Garden Design

### Summary of Activities

**Opener:** Review Take Home Activity List Confirmation (15 minutes)

- Share the results of their conversations with families
- Discuss seeds TREES will provide and those that farmers will need to procure

**Activity 1:** Completing the Top View Map (30 minutes)

- Explanation of top view map
- Transfer gathered information from Take Home Activity to flip chart paper
- Complete top view map with any missing information

**Activity 2:** Farm and Field Challenges Field Walk (45 minutes)

- Small groups walk around field to look for potential field challenges
- The group gathers and Host Farmer shares challenges they face
- Farmers update top view maps with this information

**Activity 3:** Forest Garden Design (1.5 hours)

- Design a Forest Garden
- Present Forest Garden designs

**Activity 4:** Sharing Forest Garden Designs, Review of Optimization Techniques and Workshop Closure (20 minutes)

- Present Forest Garden designs
- Review the Optimization techniques in the Forest Garden
- Paired Forest Garden review
- Workshop Evaluation
- Assign Take Home activity



## Opener: Review Take Home Activity, “Crop Selection Confirmation Research”

### Description

Farmers share some of the conversations they had with family members and market research that they did. They share whether any of their crop selections changed as a result of these conversations and research.

### Instructions

Ask farmers to share what they found when doing their confirmation conversations. Allow time for many farmers in the group to share their experience having these conversations and if any new information emerged.

- How did the conversations with your household members go?
- Did you learn any new information?
- Did you change any of your crop selections or ideas about what you want to grow as a result of them? If so, what changed?
- Did you discuss the various trees, vegetables, and other products you selected in the planning module with your family? Have you made any changes as a result?

Next, the Facilitator will share the list of tree vegetable seeds that TREES will provide to the farmers. Inform them that they will receive these seeds at the time of planting. They should write these down in the table provided in their Farmers Workbook. As part of the take-home activity, they will list the other types of seeds they will need to procure for themselves.

- Now that you know what types/varieties of seeds, seedlings, and/or cuttings TREES will provide, can someone tell the group which other seeds you will need to find on your own?
- What specific varieties will you look for? Why?
- Can you find OPV varieties of this seed? Why are OPVs beneficial?
- Where can you find the seeds/seedlings/cuttings you need? Are they available for purchase? Trade? Where?



## Activity 1: Completing the Top View Map (30 minutes)

### Description

In this activity, the farmers take the information collected from the Take Home activity after the previous workshop and create a top view map. The facilitator demonstrates with the host farmer's top view map, and each farmer completes their own top view maps in relation to it and the questions. Top View Maps should show the borders of their fields and any existing structures, major trees or important features to consider in their own and neighboring fields.

### Instructions

#### 1. Setting up a Top View Map

In an area where everyone has enough space to work, give each farmer a piece of large flipchart paper to use for drawing their Top View map. Explain what a Top View Map is, and how it will be used for the workshop as well as the rest of the Forest Garden program.

The first step of designing our Forest Gardens is creating a map of what is already there. We call this a Top View Map, and it represents a bird's-eye (aerial) view of the Forest Garden field and the land immediately surrounding it.

- What is a top view map?
- How is it helpful for designing the Forest Garden?
- How will you create it?

Using the example of the host farmer's map, review the top view map Take Home exercise. Have each farmer transfer their drawing of their field shape from their Farmer Workbook onto the flipchart paper, using black markers. (Color markers will be used for the Forest Garden design portion in a later activity)

- Was it easy to get the field shape and perimeter of your fields?
- Now we will mark which direction North is on the map. What is this helpful for?

#### 2. Filling in the Top View Map with Other Details

"Now that you have the border of your field, we will update the other information you were asked to collect from your field at home. We draw the physical features of the field as accurately as possible with regard to location and size."

Ask the host farmer these questions and demonstrate filling in this information on their flip chart for the group to see. Then have each individual farmer update their maps as well, during the discussion, if there are any things they forgot to add.

- What water do you have access to? (pump, pond, roof water catchment)
- Where is it located in your field? Go ahead and draw it on your map now.



- Is your field sloped? Where are the highest and lowest points? How will you mark them on your map?
- What are the existing large trees and structures in your field? Where are they located? How big is their canopy? Go ahead and draw them in.

### **3. Draw What is Outside the Field**

Finally, draw the things that we see immediately outside of the field that may affect the future Forest Garden. These may be good or bad things. Examples include:

- Neighbors who are rearing bees
- Dead trees or piles of brush next to the field that may attract pests
- Other fields where pesticides are sprayed
- What else might be included?
- What are the features in neighboring fields that you think should be included? Go ahead and draw these onto the map.

Now you each should have an updated top view map showing field borders, existing structures and large trees, water sources and other nearby things that might influence your field.

## **Activity 2: Farm Challenges Field Walk (20 minutes)**

### **Description**

Whereas the issues of household needs and marketable products were discussed in the Forest Garden Planning module, in this issue, the group looks more closely at field-based needs and how to improve and restore their field. Small groups walk around the field to observe challenges including those around soil, wind, pest, and erosion and other agricultural issues. They regroup as a large group where small groups share observations and the host farmer confirms observations and shares other major challenges that they face with farming in their field. The large group updates these observations on the Top View Map and will refer to it during the design process in the following activity.

### **Instructions**

#### **1. Small Groups Observe Field Challenges**

Divide the group into small groups to explore the field. Have them look for any farming issues they might observe, including issues of soil fertility, pests, wind and water erosion and anything else.

#### **2. Discuss Observations and Farming Challenges**

Regather as a group in the field and ask small groups to share their observations of the field, and the host farmer to confirm some of these observations and expound on the challenges they experience. For anything that requires demonstration, the host farmer may point out things to



the group in the field. After each issue, share briefly how the Forest Garden will help respond to those issues, and that designing and implementing the Forest Garden Approach will allow them to have more solutions, which they will learn in future workshops.

Example:

- *To the small groups*
  - What soil fertility challenges did you observe?
- *To the host farmer*
  - What soil fertility challenges do you have? Do you use chemical fertilizers?
- *To the entire group*
  - How might trees help with soil fertility? What kind of trees would be good for this?
- What erosion issues did you observe? What erosion challenges do you have? Where on the field? Do you have challenges with wind? How might trees help with erosion and wind? What kind of trees would be good for this?
- Did you observe any pest challenges? What are your challenges with pests? Do you use chemical pesticides? How might a Forest Garden help with pests?
- Any other farming challenges that you observed? What other farming challenges do you have with the land that people have not mentioned? What ways can trees help with this?

### **3. Update the Top View Map**

Return to the mapping area to update the Host Farmer's Top View Map according to the observations. Each farmer should think about the same questions and update their own maps accordingly.

- Are there any seasonally flooded areas, gullies, and severely eroded or degraded areas?
- Are there areas of really healthy or really poor soil quality? Where are they? Draw them on your map.
- Are there areas of animals entering your fields? Draw this on your map.
- What direction do strong winds come from? Draw this on your map.

## **Activity 3: Forest Garden Design**

### **Description**

Each farmer will continue working on their flipchart paper with their Top View Map, which they drew in black marker. Now they will add, using colored markers, each of the Forest Garden elements onto their map. Though farmers are each creating their own design, farmers form small groups to assist each other in completing the activity and sharing a group of markers. The facilitator demonstrates on a flipchart each step and the farmers complete it on their own paper. Step by step, they move through the design of their individual Forest Gardens. Together



they talk about protection and diversification in a Forest Garden. The facilitator reads the description and key questions for each Forest Garden component, and the farmers then draw each component on their flip chart paper. To the extent possible, encourage farmers to label their map and provide as much detail as possible using words, letters, symbols, or small drawings of crops to label tree types and elements such as “compost” or “permagarden”. Literate farmers are welcome to create a key to define the elements of the map.

## **Alternative**

*The ideal is that farmers design their own Forest Garden through this exercise. However, for programs whose farmers may not be capable of designing their own Forest Garden independently during this exercise, each small group may design the host farmer’s forest garden. The facilitator will still walk them through the steps but each group may come up with their own design based on what they have seen in the host farmer’s field and discuss together. In this scenario, each farmer will need to complete the design for their own Forest Garden for homework.*

## **Instructions**

In a central and shaded location, divide the group into small groups where everyone has access to the design materials and can see the demonstrated example with the facilitators. Share with the group that everyone will walk through the process of designing their Forest Garden with the same steps.

## **Protection**

Over the years, we have found that farmers have a much higher success rate with growing fruit trees and permagardens when they have first sufficiently protected their fields from risks. So before we talk about food crops and market opportunities, we are going to discuss how farmers use rows of trees to protect the field and begin improving the soil. The first few agroforestry techniques we will explore are therefore Green Walls, alleys and contour rows.

### **1. Design the Green Wall**

The first step in establishing the Forest Garden is protecting it from animals, wind, and storm water damage. We are going to add a Green Wall to each design now. The Green Wall will be multiple rows of trees around the field to both keep the livestock out and to protect the field from storms. The trees planted in the Green Wall will be pruned and harvested for secondary products, including berries and branches.

- Is your field at risk of livestock entering and eating your seedlings? Are there times when storms can damage the field (erosion) or the crops growing in the field?
- What is the Green Wall? (2-3 lines of trees)
- What purpose does it serve?
- Will you be constructing a dead fence to protect your Forest Garden in the first year? Where will that go? And how will you draw it? Add it to your map.



- What trees will you be using in your Green Wall?
  - Which thorny trees will you use in the outer row? How closely should they be planted?
  - The second row will be staggered to save space and make the living fence form faster. Which trees will be in the second row to strengthen the Green Wall? More thorny trees or a different type?
  - What types of taller trees will you plant on the third row to form the windbreak? How far apart will they be spaced? How tall will these trees grow?
  - How much of the field will windbreak trees protect (10x the height of the tree). If your field is longer than this, will you need another windbreak row? Where would this go in your design?
- How will you represent the Green Wall on your map? (maybe 1 thick green line, maybe 3 lines)
- Where will the Green Wall go on your map?
- Why will you plant it slightly inside your field border rather than on the border line?
- Why should farmers leave 1 m between the dead fence and green wall?
- Write the species you are including in your Green Wall in the space provided in the Forest Garden design section of your Farmers Workbook.

## 2. Design the Alleys and Contours

Once the Green Wall is added to protect the perimeter of your field, you will add alleys and/or contour rows to protect the soil and generate secondary products. Note that these two agroforestry technologies do not exclude each other. By using a combination of trees, grasses and other plants, a field can have both alleys and contour strips. The alleys can be within the contour rows, and the contours can be made of trees, grass strips, and other vegetation.

### *For sloping fields:*

First think about whether your field is very sloped. If it is a slope of 10% degrees or more, then you will add contour tree lines to the field to protect the soil from erosion. (If less than this, vegetative strips will be added in Year 2.) Look at your map.

- What purpose do contour tree lines serve?
- Which types of trees will be used for contours tree lines? How closely must they be planted together?
- What does it mean to “follow the contour” of a hill?
- Where is the highest point of your field located? This is where you will start to add a contour tree line. From there you will add another tree row as you descend down the slope two meters vertically.
- How many contours tree lines will you add? (it depends on the slope; one contour per 2 m drop in elevation)
- Add the contour tree lines to your map
- Write the species you are including in your contour planting in the space provided in the Forest Garden design section of your Farmers Workbook.



#### *For flatter fields:*

Farmers will plant alleys rather than contours on flatter land. Alleys may also be used in sloping fields between contours.

- What primary purpose do alleys serve?
- What secondary purpose(s) may they serve? Fertilizer? Fodder? Windbreak?
- What types of trees will be used for alleys?
- How many alleys will you have in your field?
- What direction should the lines go?
- How far apart should they be spaced?
- How long will they be?
- Write the species you are including in your alleys in the space provided in the Forest Garden design section of your Farmers Workbook.

### **Diversification**

Farmers diversify their fields with trees and other crops to meet household needs and market opportunities.

### **3. Design Fruit Trees**

Fruit trees are an important part of the Forest Garden. They are a long-term investment, so planning is very important. Share some best practices and good ideas in fruit tree establishment, and then guide farmers through adding fruit trees on their maps.

Introduce the following ideas to farmers and invite their ideas and reactions.

- In the Forest Garden design, each family can have both a set of fruit trees meant for household consumption, as well as a set of commercial fruit trees. Ultimately some farmers plant dozens of fruit trees while others plant hundreds.
- Combine faster maturing varieties with slower growing varieties to accelerate production.
- Think about where the fiercest storms will be coming from when the trees are flowering, and place the hardiest trees - or those meant to serve as a windbreak - on the windward side.
- How can you maximize the commercial varieties of fruit trees in the field without having high concentrations of single species? Stagger the lines, similar to the living fence, so that more trees can fit.
- Diversity is important when it comes to pest resilience. Avoid planting row after row of the same varieties. Use the alleys, for example, as vegetative barriers.
- By gardening at the base of newly planted fruit trees, they can receive a lot of additional water through their first year.



Once the facilitator has introduced these ideas on fruit tree establishment, ask the following questions to help farmers begin adding fruit trees to their maps:

- How many different types of fruit trees will you plant?
- How much space do large fruit trees like cashew, mango and avocado take up? How many of them can you actually fit in your forest garden based on the area you have?
- What is the spacing for smaller fruit trees like papaya, banana, guava, citrus?
- Where will you plant them?
- How will you represent different types on the map?
- Add them to your map. If you would like to label them with their names, you may do that.
- Write the species you are including in the space provided in the Forest Garden design section of your Farmers Workbook.
- Mark the point where the fruit tree will be planted, and consider drawing a circle around it to show the space it will fill when it matures.

#### **4. Design Timber and Other Trees**

Now let's think about timber trees.

- What kind of timber trees will you plant?
- Where will you plant them in your field?
- How tall will they grow?
- How will you represent them on your map?
- Why should eucalyptus and pine trees be avoided in cropping areas?
- Add them to your map.

Other trees

- Are there any other tree types (medicinal or indigenous) that you would like in your Forest Garden? Those that you have not yet added?
- What are they?
- What will they provide you?
- What considerations should you take in placing them in your design?
- How much space do you want to leave open for permagarden in the future?
- Add them to your map.
- Write the timber or other species you are including in the space provided in the Forest Garden design section of your Farmers Workbook.

#### **5. Design a Permagarden Area**

Now, looking at some of the spaces between the Alleys and Contours, we will design our first permagarden area, and then you will be able to apply this same process to create more permagardens across the field.

- What is a permagarden?

- How big will each permagarden area be? (approximately 10 m x 10 m and in between rows of agroforestry trees).
- What will be grown in the permagarden?
- Are there any parts of this Forest Garden that are better suited than others for the Permagarden location? Why?
- Does the site have easy access? Is it near the home so that family members can easily check on and work in it regularly?
- Where will the family get water for the garden? Can rainwater be captured or guided underneath the garden beds from the roof of the home or nearby slopes?
- Is the area protected from wind, intruding animals, and children? Is this necessary for the whole garden or just parts of it? (especially important for the vegetable nursery)
- Should the location for the nursery be different or the same? Where would you put the vegetable nursery?
- Will there be any trees around the permagarden area? How might they affect shade?
- Which crops might like shady areas and which will need more sun?
- As the other trees you have put in your design grow, will they shade out your permagarden? Do you want to maintain one without many tall trees to have a permanent permagarden even after the trees are big?
- How can a hedge along the border, such as a grassy row of vetiver, help protect the garden area? What would be a good tree for this kind of hedge?
- Add the permagarden area on your map. (Instruct farmers to designate at least a 10 x 10 m area, but they are welcome to add bigger areas.)

## **6. Add Any Potential Future Water Points**

Using the host farmer field map as a demonstration, add the location where the farmer could add a water access point in the future. If running water is a possibility, the point should likely be located on the side of the field nearest the main water line. Otherwise, the water access point may be a basin or barrel that the farmer can install in the future. The door, nursery, and water access point may all be near each other on the map.

- What type of water storage tank do you hope to install?
- Where will it be located in your field?

## **7. Add the Tree Nursery**

You have just added a lot of trees to your Forest Garden Design. You will be producing most of these trees yourselves in a Tree Nursery. Some of you may have your Tree Nursery located near your house, and others may have it in your Forest Garden. Add your Tree Nursery to the map, either in the field where it will be located, or outside the field if it will be at the house away from your field.

- How big will the tree nursery be?
- How much extra space should be added to the area, besides what will be taken up by the trees?



- Why is this space important? (important for working, having a spot to bring soil amendments)
- How many trees will you be producing?
- Of all the trees you just added to the design, which ones will you not be producing (a few grafted fruit trees)
- Add the tree nursery to your map.

### **8. Add Compost Areas**

Compost is a very important technique in the Forest Garden for creating a good fertilizer for the permagarden and tree nursery. We will now add 2-3 compost areas to the design.

- How many composts are required to be established this year?
- Why is it important to have 2-3 compost areas?
- Where should they be located? Why should they be located in those places?
- How much space should be set aside for it?

### **9. Extra Space and Staple Crops**

Now we have added all of the major elements of the Forest Garden. It will take a while for the fruit trees to grow large. In the meantime, what space do you have left in your field?

- What crops or products will you plant around the trees when they are still small?
- Are there any staple crops to avoid growing in the first year when seedlings are small? Why?
- How far should they be away from the Green Wall?

## **Activity 4: Sharing Forest Garden Designs, Review of Optimization Techniques, and Workshop Closure**

### **Description**

A few volunteers share their completed Forest Garden designs. The group discusses the connection between the Forest Garden and water, soil and pest management. Farmers pair up to each share their Forest Garden Design with each other. They evaluate the workshop and the facilitator assigns the take-home activity.

### **Instructions**

#### **1. Present Forest Garden Designs (15 minutes)**



Choose 2-3 volunteers to share the designs they have just created. Have them describe the mapping process of the existing plot and any questions, concerns. Ask them to describe their map of recommended Forest Garden plants, the location of those plants, and the benefits you believe those plants will give the farmer and their family. If the group has people with different literacy levels, be sure to include one or two low literate farmers in the presentations.

- What do you like about this design?
- Is the nursery located near a water source?
- Is the compost location strategically located?
- Is the number of trees appropriate for the space? Are there too many trees? Not enough trees?
- As the trees grow and shade out the crops, what products (shrubs, ground covers, roots, vines, etc) will you grow underneath your trees?

Encourage all participants to update their own designs based on any good ideas they learned from the presentations.

## **2. Review Optimization and Regeneration Techniques in the Forest Garden (15 minutes)**

Explain to the farmers that we discussed several farmer challenges earlier in today's workshop, with particular attention on soil fertility, water availability and pest management. No one technique is able to replace chemical fertilizers and pesticides, but rather we have now assembled a set of agroforestry techniques and technologies in our Forest Gardens, which when used together, enable every farmer to a) continually improve the quality of soil without chemical fertilizers, b) combat pests without harmful pesticides, and c) make the most use of all the rain and moisture.

We discussed some of the techniques that we will do to help meet these goals, and there are actually many additional ones we'll mention quickly now that you can look forward to learning over the next year.

Your Forest Gardens will ultimately be more resilient to pests than your field is now.

- What are some practices and elements that you will do in your Forest Garden that helps to reduce or manage pests?
  - Today we discussed Green Walls to keep livestock out, sectioning the Forest Garden with lines of trees, and planting diversity. We will also train farmers to do smart variety selection to reduce pest prevalence; to repel insects with companion plants; to rotate crop families; and to scout their fields and maintain good sanitation.

We will also teach you many techniques to keep your soil and plants healthy.

- What are some ways you know we can improve soil and keep crops healthy?



- Today we discussed alley cropping and planting contour rows, adding nitrogen fixing trees, and creating compost pots.
- 

We will also train you to use a variety of techniques that help improve soil and conserve water.

- What are some of the major water conservation practices you will learn? We spoke of a few of them today. that can be used?
  - Creating earthworks in ways that help trap more moisture, including mulching, cuvettes, half-moon berms, cover crops, dams, water catchment.

### **3. Paired Forest Garden Sharing (10 minutes)**

Farmers pair up and share their Forest Garden designs. They discuss these questions and share the answers with each other.

- What do you like about this design?
- Is the nursery located near a water source?
- Is the compost location strategically located?
- Is the number of trees appropriate for the space? Are there too many trees? Not enough trees?
- As the trees grow and shade out the crops, what products (shrubs, ground covers, roots, vines, etc) will you grow underneath your trees?

### **4. Farmer Workshop Evaluation (3 min)**

Briefly ask participants these questions to evaluate the success of the workshop and identify areas for improvement.

- What was the best/most important thing you learned today?
- Is there anything that is not clear? Any remaining questions?
- What is one thing that could be improved about the workshop? Any other suggestions?

### **5. Assign the Take Home Activity**



## Take Home Activity

### Description

Farmers will share their designs with their family to get family input and update them based on that input. Using their updated Forest Garden Designs and their list of crops and trees from Forest Garden Planning, farmers will begin to think about where they will get their seeds. They will receive the list of seeds, seedlings and/or cuttings that TREES will provide, and should think about any others they have designed into their garden, where they can find them, and whether they will harvest or buy them.

### Instructions for Farmers

1. Write down (ask someone to help if needed) the planting materials (seeds, etc) that TREES will provide in the table provided in the Forest Garden Design section of your Farmers Workbook.
2. Refer to all the trees, vegetables, etc. you and your family have chosen to plant from the Planning and Forest Garden Design sections of your Farmers Workbook. In the table provided in the Farmers Workbook, write down the seeds and materials your family will need to procure on your own, leaving out those that TREES will provide.
3. Go home and share this newly created design with your family members. See if they have any other thoughts or ideas or things to change. Update the design together so that it reflects what you all will do on the field as a household.
4. You will bring back your design to each workshop.
5. Thinking about what you want to grow, and what TREES will give you as part of the program, think about where you will source the rest of the seed. Where can you find it? Will you buy it or collect it?

### Follow-up

The Lead Farmer will follow up in person to go over the final design see if any updates have been made on the design and where the farmer is thinking about sourcing seed. They will revisit these take home assignments in the following workshop.



## Forest Garden Design Performance Measurement Checklist

As a result of this training, it will be observed that the farmer has:

- ☐ A completed top view map of the farmer's field with a Forest Garden Design including the following elements:
  - Dead fence 1 meter from Green wall (for regions that use a dead fence)
  - Green Wall
  - E-W Alleys
  - Contours (if relevant)
  - Permagarden area(s)
  - Main fruit trees
  - Main timber trees
  - Tree and Vegetable Nursery locations
  - 2 or more compost piles
  - Areas of other staple crops that will be planted
  - Water source
- ☐ A list (written or verbal) of locations they will source seed that is not provided by the program.

## Tree Nurseries

### Goal

In the workshop, farmers will observe and practice techniques for preparing a tree nursery site, constructing nursery beds, and pretreating and planting seeds. After understanding the principles of nursery maintenance and the benefits of seed pretreatment, farmers will sow their seeds in the newly constructed nursery on their own farms.

### Learning Objectives

By the end of this module farmers will be able to:

1. Understand the benefits of tree nurseries.
2. Employ best practices for preparing and constructing a tree nursery site.
3. Pretreat commonly used tree seeds.
4. Use various seed sowing methods for nurseries.
5. Use various vegetative propagation methods for nurseries.
6. Use best practices for tree nursery maintenance and management.

### Venue and Timing

This module should be facilitated three to four months before the start of the main rainy season. It should take place at a well-situated participant farmer's site. The Forest Garden should have a nursery site identified prior to the workshop. Though individuals' nurseries rarely need to take up more than about 50 square meters of space, the site for this training event should be spacious enough for all trainees to safely work around each other during module activities.

### Relevant Technical Manual Chapters

- Chapter 4: Seeds
- Chapter 6: Fruit Trees
- Chapter 5: Seedling Propagation
- Chapter 13: Permagardening (Convenient Spacing Tools section)

### Preparation

- Identify a nursery site (on the lead farmer's or a participant farmer's land) where the training will take place and inspect the site to make sure it meets the general nursery site requirements.
- Decide which tree seeds to provide, based on Forest Garden designs and applicability for the project area.
- Depending on the tree species that participants will grow, and resources available (e.g. will they have tree sacks?), determine which tree nursery techniques (bareroot beds, tree



sacks, and/or vegetative propagation) and seed pretreatment techniques (e.g. soak, scarify and soak, boil and soak, etc.) need to be covered with the group.

- Prepare 100-150 seeds for planting, based on the selected species' pretreatment requirement. **Note that seeds must be tested for viability before the workshop via germination tests.**
- Prepare cuttings, if necessary.
- Make sure all equipment and materials are available for the pretreatment activity.
- 3-4 weeks before the workshop, ask the lead farmer to sow several seeds in 10 tree sacks and care for them. A few of these should be oversown so that thinning can be demonstrated.
- Be sure to review the Forest Garden design along with the host-farmer and tell them to prepare materials for protecting the nursery (e.g. shading and dead fence) before the workshop.
- Depending on the climate and soil type, the host farmer may need to continuously wet the intended nursery site to prepare for planting in the week leading to the workshop.
- Choose 2-3 trees or crops to use in vegetative propagation. Cutting should preferably be taken from the farm as part of the demonstration if possible.
- Have lead farmer get some fruits ahead to show basic demonstration of seed extraction of fruit
- Identify suitable mother plant/tree for vegetative propagation.

## Supplies

- ☐ Materials for soil amendment
- ☐ 50 tree sacks for filling and setting up the nursery
- ☐ 5 spade shovels
- ☐ 1 rake
- ☐ 2-3 hoes
- ☐ 3 watering cans
- ☐ Machete
- ☐ Materials for building shading structures for nursery beds: corner poles, cross-poles, and shading materials
- ☐ 1 soil sieve
- ☐ 5 Nail clippers (1 set for each small group and 1 set for each facilitator)
- ☐ 100-150 pre-treated multipurpose tree seeds
- ☐ 100-150 multipurpose tree seeds for pretreatment practice
- ☐ 2 bowls/plates to show pretreated vs untreated sprouting seeds
- ☐ 20-25 fruits of 2-3 varieties for seed extraction
- ☐ Cotton cloth for wet fruit extraction
- ☐ tools for fruit seed extraction (knife, machete or other metal implement)
- ☐ 10-15 cuttings for vegetative propagation



- ☐ Secateurs for vegetative propagation with cuttings
- ☐ 5 tree sacks with several already germinated trees for thinning and pruning demonstration
- ☐ Water
- ☐ String for straight planting
- ☐ The first tree seed distribution and tree sack distribution for each participant

## Total Time

~4 hours

## Handouts in Farmer's Workbook

- Nursery Construction
- Nursery Species Chart

## Tree Nurseries

### Summary of Activities

**Opener:** Finding a Nursery Site (30 mins)

- Introduce workshop topic
- Identifying an ideal nursery location

**Activity 1:** Build a Tree Nursery (1 hour)

- Mixing soil and filling sacks
- Building beds (germination, bare root and tree sack)
- Protecting the nursery

**Activity 2:** Seed Pre-treatment (45 mins)

- Why pretreat seeds?
- Pretreating different types of tree seeds
- Pretreating multipurpose tree seeds
- Pretreating timber tree seeds
- Extraction and Pretreating fruit tree seeds

**Activity 3:** Sowing Seeds (45 mins)

- Demonstrate sowing techniques
- Sowing multipurpose tree seeds
- Sowing timber tree seeds
- Sowing fruit tree seeds
- Using germination beds
- Group practices sowing techniques

**Activity 4:** Vegetative Propagation (30 mins)

- Discuss vegetative propagation
- Prepare and plant cuttings

**Activity 5:** Nursery Care (30 mins)

- Discuss the importance of raising healthy seedlings
- Demonstrate proper watering techniques
- Demonstrate proper weeding techniques
- Demonstrate proper thinning techniques
- Pruning green wall seedlings
- Hardening off

**Activity 6:** Closing debrief and Explanation of Take Home Activity (15 mins)

- Debrief workshop activities



- Assign Take Home Activity
- Participant Workshop Evaluation

**Take Home Activity:** Establish Your Tree Nursery

**Appendix A:** Local Seed Pretreatment Chart

**Appendix B:** Local Seed Sowing Chart

**Appendix C:** Seed Germination Protocol

## Opener: Finding a Nursery Site (30 minutes)

### Description

The facilitator introduces the workshop topic: growing different types of tree seedlings in a nursery. The group discusses tree nurseries and the facilitator provides a brief definition of nurseries and the types of trees that can be raised within them. Following the introduction, participants will divide into small groups and each group identifies where they think the best site for a nursery would be on the farm. Note that if the site most group members choose is different from the site the facilitator and host farmer have chosen beforehand it is okay; the facilitator explains why the spot was chosen and why the other spot may be a suitable alternative (or not) to become a second nursery or the new nursery next season.

### Instructions

#### 1. Introduce the topic of the workshop

Open discussion by stating the purpose and importance of nurseries and talking about what can and should be raised in the nursery.

- What is a nursery?
- Why do we use the nursery? How is it different from **direct seeding**? (pros and cons of both)
- Who here has used a nursery before? For what things?
- What types of trees are we growing in the nursery? (Introduce the specific trees being planted today. Be sure to mention the name of the tree in the local language if there is one.)
  - Multipurpose trees - trees that provide fertilizer, animal fodder, or erosion control. (Leucaena, calliandra, sesbania, moringa, etc.) (I.e. anything that is not a fruit tree.)
  - Fruit trees - trees that provide fruit for consumption or sale. (Citrus, papaya, avocado, cashew, etc.)
- Are nurseries only for trees? (No. Certain crops like cabbage, lettuce, amaranth, and tomatoes do better when planted in a nursery)

#### 2. Identifying an ideal nursery location

Explain some characteristics of a good nursery site and break the large group into small groups to identify the best site on the host farmer's farm.

- What characteristics make a good nursery site?
  - Sufficient area
  - Suitable microclimate and soils
  - Water of adequate quantity and quality
  - Security from theft, vandalism, animals, children
  - Appropriate drainage—slight slope if needed



- Wind protection

Groups should move around the field and discuss possible locations. Multiple groups may select the same spot. Gather as a large group and look at all the selected locations to discuss the pros and cons of each site.

## Activity 1: Build a Tree Nursery (1 hour)

### Description

After the best site has been identified and approved by the host farmer, the facilitator teaches everyone how to build nurseries using bare-root and sack seedling growing methods. The facilitator and host farmer should collaborate beforehand to determine the exact dimensions and style of beds needed. The facilitator begins by talking about soil mixtures for nurseries and provide the optimal ratio of the amendments being used for this activity. Each group prepares a nursery bed to practice each method. The group also talks about and practices different protection measures including a shade structure or dead fence around the nursery.

### Instructions

#### 1. Amending the soil and filling tree sacks

Begin by explaining why good soil in nurseries is the foundation of the success of trees.

- Why is soil so important for seedlings?
- Why do nurseries have special soil needs compared to the rest of the Forest Garden?
- How do we make the best soil for nursery seedlings?

Explain why amendments (additional supplements to the soil like wood ash, eggshells, or compost) should be added to the nursery soil mixture referring to each element. Explain that the topic of soil amendments and compost will be covered in more detail in the future workshop “Composting.”

- What is a **soil amendment**?
- What kind of things might we want to add to the soil? Why?
  - Why do we add wood ash or charcoal to the soil?
  - Why do we add compost?

Demonstrate how to create the soil mixture and demonstrate how to fill a few tree sacks.

- How much of each amendment should you mix in?
- What is the best way of mixing?
- How much water do you use? How moist should the mixture be?
- Is there a difference between soil mixed for tree sacks and soil mixed for bareroot beds or germination beds?
- How do you fill tree sacks so that they stand up straight?
- How high should you fill them with soil?
- How tightly do you pack the soil?

Have the group break into small groups to mix soil and fill the rest of the sacks.

## 2. Establishing nursery beds

Lead a discussion on the relevant type of bed depending on which technique is being worked with. Explain which dimensions (1m x 3m, 1m x 1m, etc.) and style (sunken, flat) the group will be constructing and why. During instruction, refer to a bed that has been created, and then break the group into small groups to continue developing beds and/or arranging tree sacks.

### *Germination bed*

- What is a germination bed and what are its benefits?
- What size should the germination bed be?
- When should a germination bed be used?
- What should the soil in the germination bed look like?
- When should seedlings be transplanted into tree sacks?

### *Tree Sack nursery*

- Which trees are best to grow in sacks?
- How do you prepare the land for the sacks?
- How do you arrange the sacks in the bed area?
- What are the pros and cons of tree sacks?

### *Bareroot*

- Which trees can be grown in bareroot beds?
- How do you prepare the beds?
- What is double digging?
- How do you mix or amend the soil to obtain the best growing substrate?
- What are the pros and cons of bareroot seedlings?

### **Optional activity: Teaching Double Digging**

Double digging will be reviewed in the Permagardening module, but if time allows, farmers should use double digging techniques while constructing the nursery, specifically bare root beds and germination beds. The facilitator should ask for volunteers and then supervise the double digging process being demonstrated to the whole group. The soil is divided into an upper layer and a lower layer. The upper layer is removed and then the lower layer is tilled using a hoe or pitchfork. The soil from the upper layer is then placed back into the hole. The facilitator should explain that this practice helps drainage and aeration while facilitating easy root growth and distributing nutrients more evenly across the soil.

## 3. Protecting the nursery

Now that you have created the nursery, begin a discussion on protection and lead the group in protecting the nursery site. (The host farmer should have materials for shading and protection gathered beforehand.)

- What can attack the nursery (livestock, pests, disease)?
- Why is it important to protect seedlings from direct sun?
- What locally-available items can you use to protect your nursery?



- How do you build a shade structure?
- How can you remove most weeds before planting your nursery? (Optional)

## Activity 2: Seed Pretreatment (45 min)

### Description

The facilitator and lead farmer identify which pretreatment techniques are relevant to the local context/trees being used. Note that some seeds must be pretreated overnight. The facilitator will prepare some seeds a day or two early so that they can demonstrate the effect of pretreatment (swollen seeds, etc.). The facilitator explains pretreatment and demonstrates the methods of pretreatment that will be used. After instruction, farmers practice pretreating seeds in stations with monitoring and feedback from the facilitator. See Appendix A: Local Seed Pretreatment Chart.

### Instructions

#### 1. Why pretreat seeds?

Open the discussion by talking about why and how some seeds need to be pretreated, gauging the group experience level.

- Who has experience with pre-treating seeds before sowing?
- Why would you want to pre-treat seeds and not sow them directly?
- What are some common seed pre-treatment methods?

Then demonstrate the seeds that were pretreated early to show how the seed germination was helped by pretreatment. Pass the two seed samples around and lead the group in comparing pre-treated seeds to untreated seeds.

- What does pretreating the seed actually do to the seed?
- Compare the seeds. Do you notice any difference between pre-treated and untreated seeds?
- From where should we source our seeds and cuttings?
  - Healthy parent plants that exhibit traits like high yields, vigor, and disease and pest resistance. *The facilitator should note that there will be a future workshop on seed saving and sourcing.*

#### 2. Pretreating different types of tree seeds

Demonstrate the necessary steps to prepare each type of seeds that the farmers will be planting in their home nurseries starting with multipurpose forest tree seeds. Refer to Chapter 9: Seed Saving and the Technical Manual for selected seed pretreatment techniques.

##### a. Pretreating multipurpose forest tree seeds

- What are some seed pretreatment methods? Scarification? Soaking?
- Why do you use a nail clipper?
- Where do you cut and how deep? Where do you want to avoid cutting?



- How long do you soak them in water?
- Do all seeds need to be pretreated before sowing? Which might not?
- *Note that pretreating a large number of seeds can be difficult. In cases where many seeds are to be planted, it may be best to skip labour intensive processes like scarification, if soaking is likely to be sufficient.*

**b. Pretreating fruit tree seeds**

- Why do we only use local fruit varieties for seeds?
- How do you treat this type of fruit tree seed?
- Do you need to remove all the fruit pulp from the seed? Why?

**c. Stations to practice**

Have small groups rotate through stations in which they are able to practice each type of pretreatment.

## Activity 3: Sowing Seeds (45 min)

### Description

With the facilitator's assistance, experienced volunteers will identify the best methods for sowing the selected tree seeds. The volunteers will then demonstrate these techniques to the group which will then sow their own seeds in the nursery.

### Instructions

**1. Introduction to seed sowing techniques**

Lead the group in discussing and identifying appropriate sowing techniques for the seeds prepared in Activity 2.

- Who has experience sowing seeds for the types of trees we have here today?
- Do different seeds need to be sown in different ways?
- Are there any culturally unique methods for sowing tree seeds? Why are they effective?
- What is direct seeding?
- Which species are good for direct seeding rather than nurseries?
- How is direct seeding done? What are the challenges with direct seeding? Would we change the way we sow the seed?
  - 2-3 per hole, or many in a line, which results in seeds being crowded and they must be thinned afterwards.
  - Soil should be amended where the trees will be directly planted so the seedlings have the best growing environment and chance of success.



- Some trees such as Leucaena and Calliandra often do well when direct seeded after pretreatment, but it can be a good practice to plant them in a nursery if you want to ensure germination and growth to a certain age..
- Plants with deep tap roots, delicate root systems, rapid growth rates, and high germination are best when planted directly. (Vegetables such as carrots, squash, onions, or maize)
- Why and how do we plant in straight lines?

## 2. Learning Stations: Sowing Techniques for each type of seeds

Move the group to the 2 sowing stations, one for fruit trees and one for multipurpose trees and walk through each station explaining the process and asking the following questions. Refer to Appendix B to provide each group with the necessary information for the tree seeds selected for sowing.

- Does this type of seed require a germination bed?
- Should seeds be planted in bags or bareroot? Why?
- Should we plant seeds individually? Should we plant a large amount and then **thin** the seedlings later when they germinate?

## 3. Group practices sowing techniques rotating through the 2 stations (multipurpose forest trees and fruit trees)

- What time of day is it best to sow seeds? Why?
- What time of day should you pre-treat your seeds, so they will be ready to sow at the right time?
- How deep should you plant the seeds?
- **Sacks:** How many seeds should be sown per sack?
- **Bareroot:** How should seeds be spaced in a nursery bed?

# Activity 4: Vegetative Propagation (30 min)

## Description

The facilitator leads a discussion on vegetative propagation and describes how it can improve the growth rate and uniformity of certain tree species. Afterwards, the facilitator demonstrates how to propagate 2-3 plants from cuttings chosen ahead of the workshop.

## Instructions

### 1. Discuss vegetative propagation

Introduce vegetative propagation to the group and describe why it might be better to grow some crops from cuttings rather than seeds.

- What is **vegetative propagation**? What are **cuttings**?



- Why is vegetative propagation sometimes preferable to growing from seeds?
- What is a “**mother plant**”? What are the characteristics of a good mother plant?
- Which locally important plants can be grown by planting cuttings? How?
  - Citrus, berries, avocados, and figs are trees that can be propagated from cuttings but are usually grafted. (The facilitator should note that more information will be given on grafting in a later workshop.)
  - Some crops like cassava and sweet potatoes are often grown from cuttings which are preferable to planting from seed (tubers).
- What are some advantages and limitations of vegetative propagation?

## 2. Prepare and plant cuttings

Demonstrate taking cuttings from a mother plant, treating cuttings for planting in the nursery, outplanting cuttings, or some combination of all. Then have the group practice doing the same things while leading a continued discussion on vegetative propagation.

- Can we grow any trees from cuttings? (No, many trees can be grown from cuttings, but many require special treatment.)
- What are the local trees we can grow from cuttings?
- How do you know when the rooted cuttings will be ready for outplanting?
- Do you have to start trees from cuttings in the nursery, or can you use them directly in outplanting?
- How should they be planted once they have developed roots? (Best practices for identified tree)
- What are the characteristics of a good mother tree?
- How long should the cutting be? (Several nodes should be presented, 3-6 nodes or usually 20-30 cm)
- Should the leaves be clipped off? How many? (Leaving only the top 1-3)
- How much of the cutting should the soil cover? How much should be exposed? (2-3 covered, 1-2 exposed)
- Is there anything you can do to help roots grow faster? (Optionally mention rooting hormone and/or rooting medium)

## Activity 5: Nursery Care (30 min)

### Description

Farmers discuss how to care for seedlings in their nursery and demonstrate proper watering, weeding and thinning techniques. The facilitator provides feedback throughout the discussions and demonstrations.

## Instructions

### 1. Discuss the importance of raising healthy seedlings

- What resources do seedlings need to be healthy? Where do they come from?
- What happens if you give them too much of any one resource?
- What happens if you plant stunted or unhealthy seedlings in your field?
- Why is it important to observe and manage pests in the nursery? Are there any insects to encourage in our nurseries?

### 2. Demonstrate proper watering techniques

Ask for volunteers to demonstrate watering techniques while leading the discussion about watering.

- What times of day should you water your nursery?
- How much water should you use to water your seedlings?/How often should you water?
- If a watering can is available, what is the proper watering technique?
- If a watering can is not available, what is the proper watering technique? What can be used?
- How do you know if you're watering too much/little? What should you do?
- When is water scarce in the area? What are some ways we can conserve water? (Note that this topic will be covered in future modules but that farmers should start thinking about it early.)

### 3. Demonstrate proper weeding techniques

Explain that weeding is an intensive process but is necessary to avoid competition for resources between seedlings and unwanted weeds. Then have volunteers demonstrate weeding techniques while providing advice.

- What is a weed?
- Why is it important to weed your nursery?
- How often should you weed your tree nursery?
- When should you start weeding in your nursery?
- Why should you keep grasses and weeds cleared around the beds?

### 4. Discuss proper thinning and transplanting techniques

Using the germinated seeds that the host farmer prepared ahead of time, demonstrate the process of thinning and replanting seedlings, while explaining its purpose and when it's done.

- Why should you thin your germinated seedlings? When?
- Which seedlings can you transplant to other pots when thinned?
- When should you transplant seedlings from germination beds to tree sacks?
- At what spacing should bareroot seedlings be thinned?
- How do you decide which seedlings to thin out and discard, and which to transplant?
- How do you transplant seedlings without damaging them?
- After transplanting, why should disturbed soil be repacked?
- Should replanted thinned seedlings be watered? When?



- Do you need to thin seedlings that are direct seeded into the field?

### 5. Discuss pruning Green Wall seedlings

Provide special considerations for pruning the live fence/green wall seedlings in the nursery, emphasizing that when the green wall is properly pruned it does not limit space in the Forest Garden.

- What's the purpose of pruning green wall seedlings? (**lateral branching**)
- Why is it important to first prune the **terminal buds** in the nursery?
- When should you do this in the nursery?
- Is this the only time they should be pruned? When else?

### 6. Discuss “hardening off”

The facilitator explains what **hardening off** is and why it becomes important when transplanting seedlings out of the nursery (outplanting) demonstrating the process in the nursery.

- What is hardening off?
- Why is it important?
- What do you do to harden off your seedlings?
- When does it start?
- How long should it last?

## Activity 6: Workshop Closure (15 min)

### Description

The facilitator guides the group in a brief review of the workshop to check for understanding and assigns the take home activity.

### Instructions

#### 1. Debrief workshop activities

The facilitator poses quick questions to the group to check for understanding and provide encouragement (5 minutes).

- Why is it important to build and use a nursery?
- What is the difference between a germination bed and a bareroot bed?
- Do you have any questions about what we practiced and learned today?
- Why is soil fertility so important to the nursery?
- Why must pests be carefully managed in the nursery?
- Will you be able to use what you learned today to build your own tree nursery? When will you start?

#### 2. Participant evaluation of the workshop



- What was the best/most important thing?
- Is there anything that is not clear?
- What could be improved?
- Any other suggestions?

### 3. Assign Take Home Activity

## Take Home Activity: Establish your Tree Nursery

Following the training, farmers will each be given small tree sacks and seeds and instructed to establish their nursery beds, shading, and practice sowing seeds in beds and sacks.

### Instructions

#### ☐ **Identify your nursery site**

Farmers determine a good location based on the following criteria:

- Sufficient space
- Suitable climate and soils
- Water of adequate quantity and quality
- Security from theft, vandalism, animals
- Appropriate drainage—slight slope if needed
- Wind protection

#### ☐ **Prepare beds (bare root and sacks) and build your shade structures over them**

Double dig and amend soils for bare root beds, mix soils and fill sacks, build shade structures, and sow the seeds you were given. The beds should be large enough to hold all the seedlings you would like to grow.

#### ☐ **Sack and seed distribution**

The lead farmer will distribute more tree sacks and seeds after inspection of participant farmers' nurseries to ensure they are properly done.

#### ☐ **Establish a group nursery (optional)**

The group may decide to gather resources and organize a group nursery if some farm locations are not suitable for individual nurseries. Either the whole group or some group members can participate and there may be multiple group nurseries based on group member location.

### Follow-up



The lead farmer will visit each farmer after 1-2 weeks to check on the establishment of the nursery. When they visit participant farmers, they will observe and provide support to farmers as they pretreat and sow several seeds, ensuring proper technique. Upon first visit completion the lead farmer will distribute more tree sacks (where applicable) and multipurpose tree seeds. The lead farmer will visit a second time 6 weeks after the training to check on seed technique and seed germination.

## Nursery Performance Measurement Checklist

As a result of this training, it will be observed that the farmer has:

*First visit—when the nursery is set up*

- ☐ Set up the nursery in a good location in relation to water access, maintenance, sun
- ☐ Protected the nursery (shade, animals, children)
- ☐ Used a good soil mixture
- ☐ Properly filled and set up tree sacks
- ☐ Properly dug bare root beds
- ☐ Review Seed pretreatment and all upcoming tasks

*Second visit—on the day of seeding or when first trees have started germinating*

- ☐ Pretreated seed
- ☐ Seeded the right amount per sack/space
- ☐ Properly thinned seedlings
- ☐ Seedlings are being adequately cared for (watered, shifted for air pruning)

## Appendix A: Local Seed Pretreatment Chart

The facilitator and/or other country technicians should compile a list of locally relevant trees and how to pretreat their seeds. This table should be consulted during the workshop or referred to by farmers for clarification as they pretreat their own seeds. Two tables are provided below: one showing an example and the other blank for facilitator use.

Name of Tree	Type of Pretreatment	Notes
Example: Leucaena spp.	Scarify and soak	Warm water, overnight, soak only if too many
Calliandra spp.	Soak	Cold water, 48 hours
Sesbania spp.	Scarify	Soaking in hot water may help but can lead to reduced germination rate
Acacia spp.	Light scarify, soak	Warm water, overnight, soak only if too many
Grevillea spp.	Remove seed coat and soak	Warm water, overnight, soak only if too many
Mango	Remove husk	Soak in warm water for 30 min then plant in tree sack or germination bed
Avocado	Suspend half in water	Presoak in hot water for 30 min
Cashew	Soak	Cold water, 24 hours
Papaya	Remove gel and soak	Cold water, 24 hours

Name of Tree	Type of Pretreatment	Notes

## Appendix B: Local Seed Sowing Chart

The facilitator and/or other country technicians should compile a list of locally relevant trees and how to sow their seeds. This table should be consulted during the workshop or referred to by farmers for clarification as they sow their own seeds. Two tables are provided below: one showing an example and the other blank for facilitator use.

Name of Tree	Spacing	Depth	Notes
Leucaena spp.	5cm in furrows 10 cm apart	3cm	Seed must be surrounded by sufficiently wet soil for at least one week. Avoid planting during times of hot, dry conditions.
Calliandra spp.	5cm in furrows 10 cm apart	2cm	Avoid putting seeds too deep in the soil as they will easily rot. Water bed immediately after sowing.
Sesbania spp.	5cm in furrows 10 cm apart	2cm	Soaking in hot water may help but can lead to reduced germination rate
Acacia spp.	7cm from each seed	3cm	Can be very difficult to sow, sprouting anywhere from 2 week to several months after sowing.
Grevillea spp.	7cm from each seed	3cm	Warm water, overnight, soak only if too many
Mango	5cm	1cm	Make sure you are planting a polyembryonic

			variety. Sown concave side down to prevent crooked stem after germination. Avoid planting in waterlogged areas.
Avocado	Individual tree sacks after germinating in water	Half submerged in soil	Acidic soils are best. 15-18 months in tree sack.
Cashew	Individual tree sacks after germinating in germination bed	Half submerged in soil like a desk phone	Do not over water or the seeds will mold.
Papaya	5cm	1cm	Strongest after germination are most likely to be male, thin them.

Name of Tree	Spacing	Depth	Notes

## Appendix C: Seed Germination Protocol

The seeds used in this module must be tested to ensure that they are viable. Technicians should conduct a germination test of the seeds that are going to be used at least 2 weeks before the workshop. Below are listed guidelines for conducting a germination test:

A germination test is an experiment designed to measure the probable **germination rate** of a given batch of seeds. The germination rate refers to the percentage of seeds in the batch that will likely develop into mature plants. If you had 100 seeds and 20 of them remained dormant after planting, the germination rate of the seeds would be 80%. It is exceptionally rare to have a germination rate of 100%, but due to improper storage, handling, and planting times it is unfortunately common to have a germination rate closer to 0%.

Germination tests should always be conducted before the planting, sale, or distribution of seeds. If we know the germination rates of the seeds we are working with, we can more easily identify problems when they arise in the field. If a farmer reports that his/her seeds are faulty and we have tested them, then we know that the problem lies in the way the seeds were planted and not with the seeds themselves.

Follow the simple steps below to conduct a germination test on the seeds you plan to work with.

### Step 1: Plan Ahead

- Germination tests take 1-2 weeks to complete. When will you work with the seeds?

### Step 2: Research

- Know how long it should take for these specific seeds to germinate.
- Know what pretreatment is required for the seeds to germinate.
- Know the origin, age, and prior storage conditions of the seeds.
- Know the ideal conditions for germination and the average germination rate

### Step 3: Select seeds

- Take a sample of quality seeds.
  - The number of seeds should be a good, round number but will depend on the seeds. For pumpkin seeds, which are very large, we may only need 5-10 seeds to obtain a proper sample. For amaranth seeds, which are very small, we may need 50-100 for a proper sample.
- All seeds must be of the same type and from the same source.
- All seed must be free of disease and should have no deformities.



#### **Step 4: Wet the seeds**

- Dip a piece of paper or paper towel in clean water.
- Spread the soaked paper onto a table and place the seed sample on top.
- Cover the seeds with another piece of paper or paper towel and roll the two up together with the seeds inside.

#### **Step 5: Germination**

- Dip the rolled pieces of paper into clean water once more.
- Place the papers into transparent plastic. (Plastic bag, container, film, etc. So long as it is transparent it will act as a small greenhouse.)
- Incubate under moderate light exposure at room temperature for 1-2 weeks.
  - Lighting, temperature, and time will all vary based on the seeds being used.

#### **Step 6: Evaluation**

- The first evaluation should occur about 4 days after incubation.
- The second evaluation should occur 7 days after incubation.
- Monitor every 4 days afterwards for species with longer germination times.
- See which seeds remain dormant and which have germinated.

That is all, you are finished! The germination rate will be the percentage of seeds that have germinated. Compare your germination rate with the species' average and see if your seeds are normal, deficient, or even highly productive. Seeds that have abnormally low germination rates should not be used or distributed. Seeds that are in long-term storage should be tested at least once a year to ensure their viability.

## Outplanting Tree Seedlings

### Goal

Farmers will understand and implement best practices in outplanting agroforestry (timber, fertilizer, fodder, barrier trees) and fruit tree seedlings. Farmers will learn when to outplant different trees, how to harden off seedlings, how to prepare planting spaces with appropriate species and spacing, and how to transplant and maintain seedlings.

### Learning Objectives

By the end of this module, farmers will be able to:

1. Learn to prepare and outplant seedlings in tree sacks and bareroot seedlings following best practices (i.e. hardening off, time of day, hole prep, transplanting) and Forest Garden design;
2. Learn to properly direct seed trees;
3. Learn to establish primary agroforestry components (green wall, alleys/contours, fruit tree segments, timber segments)
4. Learn to care for trees and replace dead seedlings

### Venue and Timing

This module should take place at the beginning of the rainy season. The training should be located at a farmers Forest Garden where there are both multipurpose forest trees and fruit trees ready for outplanting. If possible, the facilitator and lead farmer should choose a time that does not occur when important crops need to be planted.

### Relevant Technical Manual Chapters

- Chapter 7: Outplanting Seedlings
- Chapter 6: Fruit Trees
- Chapter 8: Agroforestry Technologies
- Chapter 9: Popular Agroforestry Tree Species
- Chapter 10: Tree Care (Dry Season Seedling Care section)
- Chapter 13: Permagardening (Convenient Spacing Tools section)

### Preparation

- Inspect the host farmer's nursery to ensure seedlings are ready for outplanting, at least 10 seedlings per participant, including both potted and bareroot seedlings. The facilitator should inform the host farmer to harden off the seedlings before the workshop.
- Ensure that the host farmer's family and their neighbours have agreed on the boundaries of the field where green walls will be planted, if needed.
- Invite the host farmer's family to the workshop.



- Make sure each participant knows to bring their top-view map.
- Review the proper spacing techniques for trees being used in each agroforestry technology.
- The host farmer and technician should use filled tree sacks to space out the green wall and other techniques ahead of the workshop.
- Review proper width and depth of holes.
- Ensure compost is available at the training site. Make sure basal dressing as been laid a few days before the workshop if necessary.

## Supplies

- ☐ Measuring tape
- ☐ sharp, clean knives or razor blades for pruning roots and removing sacks
- ☐ 5-10 m string/cord for each participant to create measuring tool
- ☐ 4 different color markers or tape for measuring string measuring tool
- ☐ 2 wheelbarrows for transporting seedlings
- ☐ 5 spade shovels or appropriate digging tools
- ☐ 3 watering cans with water
- ☐ Compost, manure, and other soil amendments for outplanting
- ☐ 100 m string to help keep lines straight
- ☐ Sticks for marking planting rows and spacing during activity opener
- ☐ Mulching materials for fruit trees
- ☐ 5 fruit seedlings\*
- ☐ 5 timber seedlings\*
- ☐ 80 grams of pretreated seeds of multiple varieties for direct seeding
- ☐ 25-50 sack seedlings from host farmer nursery
- ☐ 50-100 bare root seedlings from host farmer nursery
- ☐ Host farmer's Forest Garden design

\*Following this workshop, all farmers will be distributed ~5 slower growing fruit and timber trees to plant in year 1 before their own nursery trees are ready the following year. They will also be distributed seeds needed for direct seeding during outplanting.

## Total Time

Approximately 3.25 hours

## Handouts in Farmer Workbook

- Seedling care checklist
- Diagrams of agroforestry techniques and spacing

## Outplanting Seedlings

### Summary of Activities

**Opener:** Reviewing and Following the Forest Garden Design (30 mins)

- Host farmer presents their Forest Garden Design
- Discuss agroforestry design and multipurpose tree seedlings location
- Discuss fruit and timber tree design and planting fruit and timber tree seedlings

**Activity 1:** Spacing for Forest Garden Practices (30 minutes)

- Discuss the important of tree spacing while farmers create measuring tools
- Using body parts as measuring tools
- Discuss spacing for agroforestry techniques

**Activity 2:** Digging Holes for Outplanting (30 mins)

- Digging holes for outplanting fruit and timber trees and amending the soil
- Digging holes for outplanting the Green Wall
- Digging holes and direct seeding for outplanting alleys and contours

**Activity 3:** Direct Seeding

- Demonstration of Direct Seeding in alleys

**Activity 4:** Outplanting Learn-and-Teach (1 hour)

- Large Group: Discuss time in the nursery and “hardening off”
- Large Group: extracting and transporting seedlings for outplanting
- Small Group: teach small group delegates how to properly outplant trees for the Green Wall, Alleys/Contours and Fruit Trees, while the rest of the small groups continue preparing holes.
- Delegates return to their groups to instruct and supervise group members

**Activity 5:** Caring for Outplanted Seedlings (15 mins)

- Discuss seedling care with large group

**Activity 6:** Workshop Closing (30 minutes)

- Debrief the workshop activities
- Assign Take Home Activity
- Workshop evaluation

## Opener: Reviewing and Following the Forest Garden Design (30 min)

### Description

Farmers review the host farmer's Forest Garden design. After thorough understanding of the host farmer's plans, farmers will discuss the importance of each Forest Garden technique and review locations for each main technique.

### Instructions

#### 1. Host farmer presents their Forest Garden Design

Ask the host farmer to come to the front and review their Forest Garden design, having the rest of the group in a semicircle so as to see the design. Use the questions below for open discussion to the whole group, not necessarily questioning the host farmer directly.

- What are the agroforestry techniques in this design? Where are they and what are they doing?
- Which agroforestry (timber, fertilizer, fodder tree) species will we plant? Why?
- Which fruit tree species will we plant? Why?
- Where will we plant trees today? How will we orient ourselves? (East – West)
- Do you know where the boundaries of your Forest Garden site are?
- If you share that boundary with neighbours, do they agree with the boundary?
- What happens if your green wall causes a boundary dispute?
- Is it ok to plant crops among the trees you plant? What will the intercropping look like for each type of tree?
- When is the best time to plant? How do you know if the rainy season has started?

#### 2. Discuss agroforestry design and planting multipurpose seedlings

Lead a discussion reviewing agroforestry techniques and discussing planting agroforestry seedlings.

- Using the Host Farmer's design, where would the green wall be?
- What is a Green Wall, and what are the benefits?
- How does a Green Wall protect the field?
- How can you protect your Green Walls from livestock? (Construct a dead fence)
- How do you construct a dead fence? What materials can you use? How tall should it be? How far should it be from your green wall? Why?
- Is it really worth the time it takes to construct a dead fence around your young living fence? (Yes! Grazing goats, sheep, cattle, etc, can and will eat seedlings and you will have wasted months of work and resources)
- Using the Host Farmer's design, where would the windbreak be?
- How does a windbreak protect the field?



- How will trees affect soil fertility? Where will their leaves fall? can they be easily cut and carried?
- Using the Host Farmer's design, where would the alleys/contours be? (Setting out contours will be covered in further detail later, but the facilitator should briefly describe how water will interact with the proposed layout for trees.)
- What about alley crops? Contour lines? How are these different from each other?
- How do alley crops and contour lines protect the field?

### **3. Discuss fruit and timber tree design and planting fruit and timber tree seedlings**

As with multipurpose agroforestry seedlings above, move to a new area and continue to lead an open discussion about planting fruit tree seedlings while touring the field.

- Will the fruit trees we are planting be protected by the green wall?
  - Are there any fruit trees that are part of the green wall?
- What crops are good to intercrop with your fruit trees? What would that look like?
- What else might be planted while your fruit trees are growing?
- Where will you plant timber trees?
- What considerations are there when planting crops among newly planted seedlings? (Overcrowding and overshadowing trees before they are well-established)
- Are the fruit and timber trees positioned to capture water?

## **Activity 1: Spacing for Forest Garden Practices (30 min)**

### **Descriptions**

The facilitator leads the farmers in a discussion of the importance of correct spacing between trees. Alongside the lead farmer, the facilitator demonstrates proper spacing for a variety of planting methods applicable to the field: green wall, alley planting, contours, and windbreaks. Finally, Farmers create measuring tools that they can use on their farms and practice using their body as measurement tools.

### **Instructions**

#### **1. Discuss Importance of tree spacing while creating measuring tools**

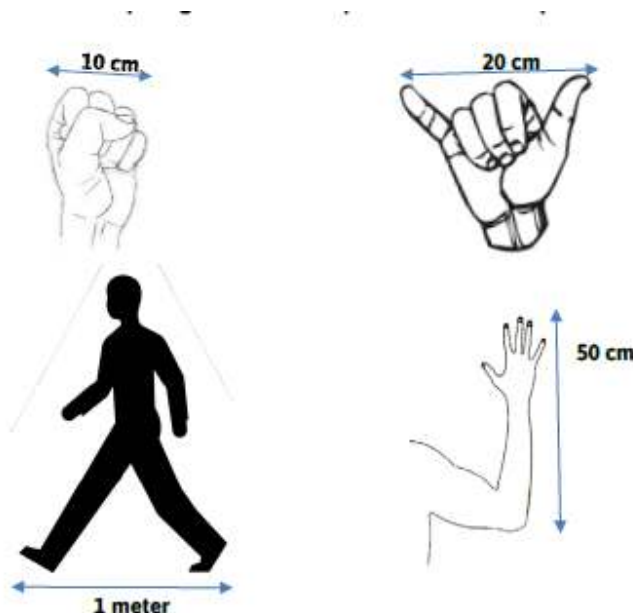
Divide farmers into 4 small groups set up around a central space so that all can hear the discussion. Using a ruler, tape measurer, or another measuring guide, cut several branches or cords at the determined spaces between each seedling (e.g. 10cm, 30 cm, 50cm, etc. in length). Bamboo may work well if it is thick, as it is very straight. One long string can be used and knots or marks made on it to have many measurements on one tool. Using markers of different colors allows a farmer to mark on the same string every meter in black, every 50 cm in red, every 25 cm in green, and every 10 cm in blue. After cutting each measuring tool, pass it along to each group member to copy. During the activity, lead farmers in a discussion of why spacing matters

in the planting of their trees: 1) to function correctly; 2) to be able to grow well and remain healthy; 3) to maximize profit and products from the trees.

- Who has used tools to space out trees you planted in the past. What trees? What measurement did you use? Where did you learn that measurement?
- Why is measurement and spacing of seedlings important?
- What happens when you plant seedlings too close together?
  - Root systems may become entangled, shading out of seedlings, and reducing growth. Fruit trees may not be able to reach their full growth potential and will not produce as much fruit.
- What happens if you plant seedlings too far apart?
  - May create large gaps for windbreaks and green walls, reducing its ability to protect your field. May not be able to harvest as much as you could as it does not maximize the space.
- The goal of the Forest Garden design is to maximize space by planting trees far enough apart that they can grow well, and close enough together that not space is wasted. Move on to the next activity once every group member has a copy of the measuring tools.

## 2. Using your body as measurement

It may be that some days you do not have your measuring tools with you at the farm. In this case, you can use your body to estimate, though it will not give as accurate a measure. Using your measuring tools, measure different areas: the span of your hand, from elbow to tip of finger, your arm span).





- What happens if you don't have your measuring tool with you at the farm? What can you do?
- What are the pros of using your body as measurements? What are the cons?
- What happens if you are slightly off on your measurement? (You can end up with many more or many fewer trees in your design than recommended)

### **Optional Activity: Comparing body measurements with measuring tool**

The facilitator asks for two farmer volunteers. Give one farmer a tool to measure and mark off trees every 25 cm and tell the other farmer to use their body part. Have them do this on a stretch of 50 m, using stones or flags to mark off the tree locations, and ask them to come back to the group with the total number of "trees" planted. The person using the measuring cord should have measured and counted around 200. The person using the body part will likely have a lower or higher number based on the accuracy of their measurements. This demonstrates how a small difference in your measuring tool may not make much of a difference on a small scale if you are only planting 5 trees, but it ends up making a big difference when using it over a long area like an entire green wall.

### **3. Discuss general tree spacing for agroforestry technologies**

Using the host farmer's Forest Garden design and the newly created measuring tools, discuss and demonstrate spacing requirements for the main agroforestry technologies in a central location to compare spacing before going out to the field to begin digging.

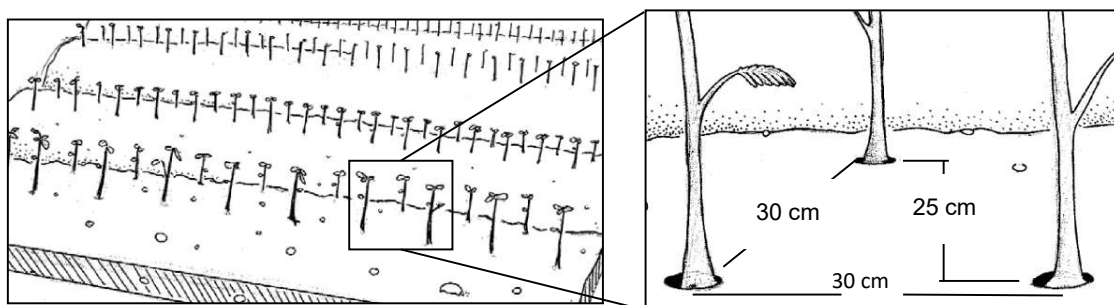
*Note: It's possible for farmers to experiment with different spacing. We have developed recommendations but farmers are welcome to experiment with other arrangements to see if there are better results (adding an extra line to the alleys or green wall, planting slightly closer or farther apart) Any deviation from recommendations should not be more than 50cm different. See Appendix A: Spacing Guidelines Chart.*

- What spacing do you imagine you will use for the technologies you are practicing?
- Is spacing different for alley cropping? For a windbreak? For a contour row? For the green wall? For fruit and timber trees?
- What is **Triangular Spacing** or **Staggered Spacing**?
- What if one farmer is using one species and another farmer is using another? (each species might have different spacing requirements and depends also on where it is being used) Species + Agroforestry Technique = spacing requirement.

### Optional activity: Teaching Triangular Spacing

Give farmers a 1 m 8 cm square area\*\* on the ground and tell them to arrange “trees” (rocks can be used) so that they are “planted” 25 cm apart and then count how many they can fit. Farmers will most likely arrange trees in a 25 cm grid which allows for 16 trees in the space (4 rows of 4 trees). Afterwards, show farmers the layout with 25 cm apart triangularly, which results in 5 rows 21.5 cm apart, and allows for 18 trees. On a small scale this is not much of a difference, but as it scales up this triangular spacing makes a big difference.

*\*\*Note: the reason the square area is 1 m 8cm is because this is the smallest area where there is a difference between triangular and rectangular spacing. If using a one meter square area, then it would result in the same number in both squares. As the area increases, so does the difference in number of plants you are able to fit between the two.*



## Activity 2: Digging Holes for Outplanting (30 min)

### Descriptions

The facilitator leads farmers in using measurement tools and sticks to mark the rows where they will plant the agroforestry trees and the specific locations where fruit trees will be planted. The facilitator should confirm precise measurements for the group to follow according to the host-farmers Forest Garden Design. The facilitator demonstrates the proper technique for digging holes for seedlings then outplants 1-2 seedlings themselves for the group to repeat in the next activity.

### Instructions



## **1. Digging holes for outplanting fruit and timber trees and amending the soil**

Move to a place where a fruit tree will be planted and demonstrate preparing a hole for planting.

- Why is it helpful to double dig?
- What are the dimensions of the hole?
- Why should fruit and timber tree holes be wider and deeper than multipurpose tree holes?
- How far apart should these fruit and timber trees be spaced?
- How early should you dig the hole? Why is it good to prepare the holes one to two weeks before outplanting?

Draw attention to the soil amendments being used today (compost, manure, wood ash, etc.) and demonstrate the proper amount to add. Note that soil amendments are covered in more detail during the composting module.

- What can you add to the soil before planting? If you do not have compost, what else can you add? Why do you add wood ash? Why do you add charcoal?
- What amendments are we using today and why?
- Where do you place amendments when planting a seedling?
- How much amendment should we use on each hole for fruit trees?
- Why is soil fertility so important for tree health?

## **2. Digging holes for the green wall**

Next move to an area of the Forest Garden where the Green Wall will be planted. Measure out spacing for Green Wall trees using the spacing tools created in the previous activity.

- What spacing should you use for Green Wall trees?
- How many rows will you plant?
- What is the spacing between trees in the row?
- Does each row have the same spacing of trees within it?
- What is the spacing between rows?
- How deep and wide should you dig?
- What is trenching? Why is it beneficial to use trenching if you are planting trees close together?
- Is it okay to not follow recommended spacing when planting the green wall?
- Are there concerns about the Green Wall occupying too much space/shading out crops? (the wall will be pruned regularly.)
- Do we need to add soil amendments when planting trees in the Green Wall?
- When should you plant the seedlings?

## **2. Digging holes for the alleys and contours**

Finally, move as a group to an area of the Forest Garden where alleys or contours will be and demonstrate measuring out and preparing holes for alleys and contours. If in a region where you will direct seed, demonstrate how to do this, while measuring the space between rows.

- Will you plant seedlings or direct seed your alleys and contours?



- If you will direct seed, how will you do this?
- How many rows do you plant for alley/contour?
- What is the spacing between trees in the row?
- What is the spacing between rows?
- Does each row have the same spacing of trees within it?
- How deep and wide should you dig?
- Do we need to add soil amendments when planting trees in the alleys and contours?
- When should you plant the seedlings?

## Activity 3: Direct Seeding

### Description

The facilitator demonstrates the process of direct seeding trees in an alley, as the group discusses when and where direct seeding is appropriate.

### Instructions

#### 1. Large Group: Discuss direct seeding

Gather the group in the location of an alley. Discuss direct seeding and demonstrate the correct spacing and planting steps for direct seeding.

- What is direct seeding?
- What areas of the Forest Garden might you use direct seeding rather than trees from the nursery?
- What species might you use direct seeding for?
- Why might direct seeding be preferential?
- How do the seeds need to be pretreated before planting, and when should that be done?
- When should you plant your tree seeds if doing direct seeding?
- What is the spacing used for direct seeding in the living fence and alleys?

## Activity 4: Outplanting Learn-and-Teach (1 hour)

### Description

The large group discusses “hardening off” and learns how to extract and transport trees and then divides into their four small groups identified in the previous activity. One small group remains behind to learn how to outplant each type agroforestry technology, while the other three groups return to the field to continue to dig holes. The delegates then bring the seedlings to be planted and teach each group what they just learned to complete the planting at each station. It is important to make sure that each group is able to rotate through the 3 areas, spending 15 minutes at each station.

## Instructions

### 1. Large Group: Discuss time in the nursery and “hardening off”

Gather the entire group back at the nursery. Introduces the concept of “short term” and “long term” trees in the nursery and then explains the concept of hardening off and checking for understanding.

- What is an example of a short-term tree? (A tree that only needs to be in the nursery for a number of weeks)
- What is an example of a long-term tree? (A slow growing seedling that must remain in the nursery for several months to over a year.)
- What is **hardening off** and why is it important?
- How long before planting should hardening off occur?

### 2. Large Group: extracting and transporting seedlings for outplanting

The facilitator instructs the group on the best practices for extraction and transport.

- How do you protect roots when extracting seedlings in plastic sacks?
  - If you are using biodegradable bags they may be planted directly in the holes.
- How do you extract seedlings from bareroot beds?
- When and how do you prune roots?
- How quickly must seedlings be planted after being extracted from the nursery?
- What is the best time of day to plant?
- How should seedlings be transported? For short distances? For long distances?
- How should you transport bare root seedlings?
- How should you transport tree sack seedlings?

### 3. Divide into small groups

Divide farmers into 4 small groups and assign one group to the Green Wall, one group to the fruit and timber trees (with the host farmer) and one group to the alleys/contours area. These farmers will continue digging holes or trenches according to the considerations identified in the previous activity as the fourth small group is the delegation for the learn-and-teach activity.

### 4. Small group Delegation: Properly planting a seedling

Instruct group delegates how to properly outplant by demonstrating how to plant one fruit tree, a section of the Green Wall and a section of the Alleys or Contours repeating the questions below for each station. The rest of the group will continue to prepare holes for outplanting.

- How deep should you plant the seedling?
- What if the hole I prepared is too deep or too shallow?
- How do you add amendments? How much?
- Are amendments necessary for each of the sections (Green Wall, Alleys/Contours, Fruit Trees)
- What is a J-root and how do you prevent them?



- How do you fill the soil back in?
- Why is it important to pack down the soil after planting?
- How tightly do you pack the soil around the seedlings?
- What should you do with all these plastic scraps that used to be nursery bags?
- What should you **mulch** the seedling with?
- How much should you water it?

(For Fruit Trees Only) Demonstrate the creation of a small cuvette around the fruit tree.

- What is a cuvette?
- How does it help the tree?
- How far should it be from the tree?
- How do you build one?
- As the tree grows bigger, you will adjust the cuvette so that it moves outward.

After finishing instruction, give the delegates the amount of trees they will collect for their first station. Then have them take the seedlings to their group and instruct them on the process of outplanting. Inform them that after 15 minutes, their group will rotate to the next station and they will return to collect the next set of trees.

### **5. Delegates instruct and supervise small group members**

Each group will be given designated seedlings in a different section of the nursery and a section of outplant holes to transfer them to. Participants will continue to outplant seedlings for 15 minutes and then will rotate to the next section when delegates will collect another batch of seedlings for that station.

*Note: Farmers should take their time transporting the seedlings: seedlings are often damaged when too many are carried. Wheelbarrows should be used if necessary.*

## **Activity 5: Caring for Outplanted Seedlings (15 min)**

### **Description**

After all the seedlings are outplanted, the facilitator will bring the group together at one of the newly planted fruit trees to discuss what they learned, answer any questions, and go over how to care for the outplanted seedlings.

### **Instructions**

#### **1. Discuss seedling care with large group**

The facilitator poses quick questions to the group to check for understanding and provide encouragement.

- What are the biggest risks to the newly planted seedlings?
- Why is it generally necessary to construct a dead fence around your site before planting your green walls?
- Are there any differences in how you should care for seedlings that are transplanted from the nursery, and seedlings that are direct seeded into the field?
- When should farmers check for dead seedlings to replace? How do you know if a seedling is dying? When should dead ones be replaced?
- When should farmers start to check for weeds and pests?
- How do you check for insects? What will you do if locusts or other insects come?
- Are livestock a threat to the seedlings? Why? How do you prevent it?
- Do you need to water the seedlings?
- Do you add mulch or fertilizer to the trees after they are outplanted?
- What is a cuvette and how can it help our seedlings/trees?
- Which fruit trees seedlings need to stay in the nursery for longer (Mango and citrus often need extra time.)
- When will you start to prune your seedlings? Why is that so important (especially for the green wall)?

## Activity 6: Workshop Closure (15 min)

### 1. Debrief the workshop activities

Check for understanding by posing these questions to the group, and takes participants' questions and address any concerns they may have.

- What is hardening off and why is it important to do before outplanting?
- Does the planting we did today resemble the plans the host farmer explained in the first activity? Did we put the trees in the right places? Did we make any changes?
- What is something you learned today that you did not know before?
- Why is proper spacing so important? Why does it change depending on the technology being practiced?
- What risks do outplanted seedlings face that they might not in the nursery?
- Will the green wall take up too much space? The windbreaks? Alley crops?
- When will you begin outplanting your seedlings and how will you apply what you learned today?

### 2. Participant evaluation of the workshop

- What was the best/most important thing?
- Is there anything that is not clear?
- What could be improved?
- Any other suggestions?



### 3. Assign take home activity

## Take Home Activity: Outplant your Seedlings

### Description

Farmers outplant fruit, timber, and multipurpose forestry seedlings from their nurseries to their Forest Gardens based on their Forest Garden designs and using the techniques learned during the workshop.

### Instructions

#### 1. Build a dead fence around your entire site

If there is any chance that livestock belonging to the farmer or neighbours will be near the farmer site, they should construct a dead fence made from the branches of thorny trees approximately one meter high around their entire site. The dead fence should be at least one meter outside from where the green wall will be planted.

- If resources are unavailable for the dead fence, farmers should work to overcome this problem by protecting what they can through traditional methods and consulting with the technician.

#### 2. Outplant fruit tree and timber seedlings, from nursery or TREES program.

When seedlings are ready, farmers will prepare their planting holes and outplant them to their Forest Gardens digging adequate holes and using correct spacing. Each farmer should review their plans and confer with immediate neighbours to avoid boundary disputes.

#### 3. Outplant Green Wall, Contour and Alley seedlings from nursery to field

When seedlings are ready, farmers will prepare their planting holes and outplant them to their Forest Gardens digging adequate holes and using correct spacing. Each farmer should review their plans and confer with immediate neighbours to avoid boundary disputes.

#### 4. Pretreat and direct seed fast growing multipurpose trees

For any seeds that will be direct seeded, farmers will pretreat their seeds and direct seed in the designated areas (alleys, contours, green wall) according to what was trained in the workshop.

### Follow-up

The lead farmer will visit each participant farmer within 2-3 weeks of the training event to ensure that your dead fence is built and to monitor and advise on proper spacing and



outplanting techniques. Within 4 weeks the lead farmer will visit again to ensure trees are being outplanted and cared for correctly.

## Outplanting Performance Measurement Checklist

As a result of this training, it will be observed that the farmer has:

### *First visit*

- ☐ Constructed a Dead Fence to protect Green Wall.

### *Second visit*

- ☐ Successfully planted the Green Wall and Alleys/Contours.
- ☐ Successfully planted and protected some fruit trees.
- ☐ Weeded, mulched (fruit tree only), and watered the outplanted seedlings.
- ☐ Replaced dead seedlings.

## Appendix A: Spacing Guidelines

These spacing guidelines have been developed by Trees for the Future through work on the Forest Garden Approach over the past years. While these are recommended spacings, it's possible for farmers to experiment with different spacing. A second table is provided for each

spacing guideline to which technicians can fill in with their agreed upon regional-specific recommendations.

Note that fruit tree spacing changes depending on Forest Garden design and recommended distance are not listed. Technicians should refer to their own expertise and the Technical Manual when planting individual fruit trees. Recommended fruit tree hole diameter also will vary regionally, so technicians should fill in the table based on their training.

Green Wall Spacing Suggestions	Purpose	Species	Spacing
<b>Outer Row</b>	Thorny trees planted relatively close to create an impenetrable hedge.	<i>Ziziphus</i> <i>Dovyalis</i> <i>F. albida</i> <i>Acacia spp.</i>	40cm
<b>Middle Row</b>	Fast growing, sturdy trees that provide structure for the green wall	<i>Jatropha curcas</i> <i>Euphorbia</i> <i>Leucaena</i> <i>Moringa oleifera</i>	15 cm
<b>Inner Row</b>	Tall, fast growing and useful trees that can serve as a windbreak, a fodder or fuel source, or crop.	<i>Leucaena</i> <i>Cassia sepium</i> <i>Gliricidia sepium</i> <i>Parkia biglobosa</i> <i>Parkinsonia</i>	50 cm

Recommendations for green wall spacing may be adjusted according to species and location.

	Alley Cropping	Windbreak	Woodlot
<i>Leucaena spp.</i>	1m between trees, 4m between rows	50cm-1m	2m
<i>Acacia spp.</i>	4-5 meters between rows	1m	2m
<i>Grevillea robusta</i>	4-5 meters between rows	1m	1-2m
<i>Calliandra calothyrsus</i>	4-5 meters between rows	50cm-1m	1-2m
<i>Sesbania spp.</i>	4-5 meters between rows	50cm-1m	1-2m

Green Wall Spacing Suggestions	Purpose	Species	Spacing
<b>Outer Row</b>	Thorny trees planted relatively close to create an impenetrable hedge.	<i>Ziziphus</i> <i>Dovyalis</i> <i>F. albida</i> <i>Acacia spp.</i>	
<b>Middle Row</b>	Fast growing, sturdy trees that provide structure for the green wall	<i>Jatropha curcas</i> <i>Euphorbia</i> <i>Leucaena</i> <i>Moringa oleifera</i>	
<b>Inner Row</b>	Tall, fast growing and useful trees that can serve as a windbreak, a fodder or fuel source, or crop.	<i>Leucaena</i> <i>Cassia sepium</i> <i>Gliricidia sepium</i> <i>Parkia biglobosa</i> <i>Parkinsonia</i>	

Tree Species	Alley Cropping	Windbreak	Woodlot

Fruit Tree Species	Spacing	Hole Diameter

## Permagardening

### Goal

For each family to grow a full nutrition diet and market garden on their land, farmers will learn to design and establish permagardens in their Forest Garden and to apply permagardening principles in the cropping patterns across alleys and along contour rows.

### Learning Objectives

By the end of this module, farmers will be able to:

1. Design and establish garden beds in a biointensive permagardening area.
2. Design and establish gardening sections in alleys or contour rows in the Forest Garden.
3. Propagate selected vegetables using nurseries, cuttings and direct seeding.
4. Care for and maintain the healthy production of garden crops.
5. Plan for and utilize crop rotation and relay cropping to maximize and sustain garden production
6. Use IPM prevention practices and solutions to repel insects and prevent infestations.

### Venue and Timing

This module should be given about four to six weeks before the start of the main gardening season. For some programs this is the rainy season, and for others it is the cool dry season that follows the rainy season. The workshop will take place on the host farmer's field. Choosing a site with a slight slope where possible may be preferable for demonstrating the creation of garden earthworks.

### Relevant Technical Manual Chapters

- Chapter 8: Agroforestry Technologies
- Chapter 13: Permagardening
- Chapter 15: Optimizing the Understory

### Preparation

- Review host farmer's Forest Garden design with the host farmer and preplan where the permagarden and vegetable nursery will go.
- Alongside the host farmer, determine which garden earthworks are appropriate for the field.
- Have the host farmer start some fast-germinating seeds 2 to 3 weeks early, to demonstrate transplanting. Help the host identify an anchor and one or two companions to start.
- Determine which locally relevant seeds will be distributed to farmers after successful implementation of permagardens (during or after workshop)



- Determine the most prevalent insect and the natural pesticide remedy that can be made to combat it.
- Prepare a list of common garden crops (especially those used in the project area) and their companions, noting the different benefits they provide.

## New Concepts and Vocabulary

- Permagardening
- Swales and berms (upslope, downslope)
- Double Digging
- Direct Seeding
- Transplanting
- Antagonists
- Intercropping and companion planting
- Integrative Pest Management (IPM)
- Garden earthworks
- Optimization
- Crop rotation
- Relay planting

## Supplies

- ☐ Flip chart
- ☐ Markers
- ☐ 1 pen for each participant
- ☐ 5 hoes, picks, shovels or other digging tools
- ☐ Stakes for laying out beds and earthworks
- ☐ 1 wheelbarrow or sack for transporting compost
- ☐ Compost or dried manure for double digging and nursery preparation
- ☐ 5 types of 10-25 gram sachets of vegetable seeds for direct seeding and planting in the nursery
- ☐ 25 vegetable seedlings of different (companion) varieties for transplanting.
- ☐ Visual cards or actual vegetables representing vegetables for crop rotation activity
- ☐ 1-2 watering cans
- ☐ Ingredients required for natural pesticide
- ☐ 1 10 liter bucket with lid for mixing natural pesticides
- ☐ 1 20 liter bucket with lid for mixing natural pesticides
- ☐ Wood Ash
- ☐ Poster/photos of rainbow nutrition, finished permagarden, and companions

## Total Estimated Time

4 hours 45 minutes



## Handouts in Farmer's Workbook

- Diagram of garden setup and design
- Diagram showing measurements (hand, arm, step)
- Diagram of triangular spacing
- Vegetable species spacing, maturity, companions and antagonists chart
- Crop rotation chart



## Permagardening

### Summary of Activities

#### **Opener: Making a Meal (10 minutes)**

- Draw a non-nutritious meal
- Draw a nutritious meal
- Discussion

#### **Activity 1: Designing your Permagarden (1.5 hours)**

- Introduction to permagardening
- Designing your permagarden
  - Step 1: Location and layout
  - Step 2: Borders and alleys
  - Step 3: Food for the Family
  - Step 4: Food for the Soil
  - Step 5: Finding Companions

#### **Activity 2: Establishing the Permagarden (1 hour)**

- Walk-through and discussion
- Earthworks and beds
- Vegetable nurseries
- Practice

#### **Activity 3: Planting the Permagarden (45 minutes)**

- Direct seeding
- Transplanting
- Planting between alleys and on contours
- Planting companions for IPM and other needs

#### **Activity 4: Permagarden Maintenance and Care (30 minutes)**

- Mulching beds
- Weeding and watering
- Crop rotation
- Relay planting

#### **Activity 5: Introduction to IPM (30 minutes)**

- Introduce Integrated Pest Management (IPM)
- Learn to make an IPM natural pesticide

#### **Take-Home Activity Review: Establish your Permagarden (20 minutes)**

- Farmers construct permagardens



- Farmers construct vegetable nurseries
- Farmers make a natural pesticide
- Farmers transplant and direct seed vegetables and companion plants

## Opener: Making a Meal (10 minutes)

### Description

This opener activity introduces has participants think about what a non-nutritious meal and a nutritious meal looks like. They will draw them on a piece of paper and then discuss the concepts of rainbow nutrition, and ensuring they grow a variety of colorful and nutritious foods in their gardens.

### Instructions

Give all participants a pen and ask them to draw a picture of what they think a non-nutritious meal they eat looks like, and what they think a nutritious meal looks like.

#### Step 1: Draw a non-nutritious meal

Ask participants to take out their Farmer's Workbook and draw in the space provided what they think the least nutritious meal they eat looks like.

- What foods might they eat in a meal that are not nutritious?
- What drinks might be included in a meal that is not nutritious?

#### Step 2: Draw a nutritious meal

Next, ask participants to draw a picture of what they think is a nutritious meal.

- What foods might be on your plate for a nutritious meal?
- What would you drink with it?

#### Step 3: Discussion

Lead a short discussion around good nutrition

- Ask a few people to tell the group what they drew for a non-nutritious meal
  - What foods did you put on the plate?
  - How are they cooked? What are they cooked with? (*fried foods, processed foods, and too much oil, fat, and sugar are unhealthy*)
  - What colors are the unhealthy foods you chose? (*artificial coloring does not make foods healthy!*)
  - What do you drink with a non-nutritious meal?



- Now ask a few people to tell the group what they drew for a nutritious meal?
  - What foods did you include? How many types of food? What color?
    - *Be sure it includes colorful vegetables and protein along with carbohydrates. Foods with sugar and fat are fine, but should be in small amounts.*
  - What do you drink with a healthy meal?
    - *Water, fruit juice (with little to no added sugar) and milk are healthy drink options. Sodas, alcohol, and drinks with a lot of sugar are unhealthy*
  - Why are these foods nutritious?
    - *Explain that nutritious meals (and snacks as well) include a variety of colorful fruits, vegetables, proteins, and more.*
    - *Explain the importance of 'rainbow nutrition'. The most important colors are dark green, orange or dark yellow, red and purple, and proteins (both from legumes but very importantly animal source foods as well (e.g. meat, fish, eggs, dairy)).*
  - What are examples of nutritious foods you can produce in your Forest Gardens?
    - *Solicit responses for fruits and vegetables of all colors, proteins and healthy oils (legumes, nuts, etc), and animal source foods (eggs, dairy, cheese, fish and meat (not too much red meat!)).*
  - How often should you and your family eat nutritious meals?
    - *They should have nutritious meals every day. It is ok to have non-nutritious foods in limited amounts, but they should primarily feed their families colorful fruits, vegetables and proteins.*
    - *Healthy meals of colorful fruits and vegetables and protein provide the important vitamins and nutrients you need for your family to be/grow healthy and strong. Eating unhealthy meals regularly can lead to poor health, and especially for children and pregnant and lactating women, it can lead to slowed or stunted growth, poor brain development, poor health and immunity against illness, and malnutrition.*
  - Inform participants that good planning in their Forest Gardens will enable them to grow a wide variety of foods all together in their Forest Gardens to provide nutritious meals for their family, and income to buy nutritious foods, every day, throughout the year.

## Activity 1: Designing your Permagarden (1.5 hours)

### Description

The first step in establishing a permagarden is design. Permagardeners can maximize productivity through good management of the associations and interactions between sunlight, water, soil, and plants. Understanding how these elements work together will help them to think through and create top view maps of their sites' layout and to design diverse permagarden beds following a few fairly simple steps.

This activity will take place in a cool, dry space where participants have plenty of room to develop their permagarden designs on flipcharts. To begin with, the Facilitator will use pictures to lead a discussion in plenary, introducing the concept of permagardening. The participants will then break up into small groups of four or five participants to think through various design considerations, and to brainstorm with each other while creating top-view maps of a permagarden bed before completing their own designs.

### 1. Introduction to Permagardening

Using the permagarden poster, the Facilitator will ask the following questions:

- What is a permagarden? How is it different from a normal garden?
- What are the benefits of a permagarden? *Be sure the following are mentioned, prompt as needed: intensive, year-round production; abundance of nutritious fruits, vegetables, herbs, and more; nutritious food for your family as well as for market/enterprise; low-input and low-cost; soil and water conservation; extend the growing season; sustain soil fertility; natural pest control*
- Looking at the examples of permagardens in the pictures, what are some of the things you notice about these permagardens?
- Where can you use permagarden concepts? *The Forest Garden is based on permagarden practices and concepts. Permagarden design principles are not just for your family's vegetable garden. They should be used anywhere in your Forest Garden or on any cultivated land.*
- Forest Gardens incorporate the same principles as permagardens. Who can recall the different layers and components we might find in a permagarden or Forest Garden?
- Does a permagarden change over time? How? What are some important considerations to keep in mind during design to account for these changes?

Permagarden design principles are not just for a family's garden area. Use these same principles in your market garden, alleys, contours and segments throughout your Forest Garden!

### 2. Designing your Permagarden



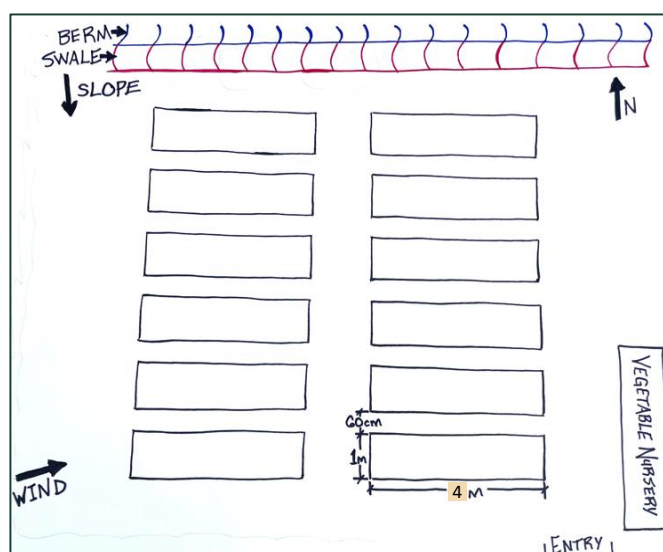
For this activity, the Facilitator will break the participants up into small groups of 4 to 5 farmers each, giving them flipchart paper and different colors of markers. Tell the groups that they will reflect on the design considerations and brainstorm together, but for their take-home assignment, each of them will develop their own designs on a piece of flipchart paper or in their workbooks, based on their Forest Garden designs and family's needs and priorities. The Facilitator will walk them through the steps below, developing a permagarden design on a piece of flipchart paper as s/he talks through each step, then walking around the groups to provide guidance and answer questions.

### **Step 1: Location & Layout**

Farmers should already know where their family's permagardens will be located based on their Forest Garden designs. In this activity, they will 'zoom in' on that site from their Forest Garden designs, drawing a top-view map of the borders of their permagarden site to fill the flipchart or workbook sheet and begin creating their permagarden designs. Though group members should discuss what they are doing, why, and ask questions to fellow group members for clarification, they should each create their own top-view map designs based on their individual site layouts and family priorities. The Facilitator will prompt participants to recall location considerations, then discuss bed layout.

- Who can recall the important considerations regarding the location of your permagarden within your Forest Gardens?
  - *Answers should include that it should: be easily accessible, be protected from livestock and extreme wind, be near a water point, receive full sun for at least 4 hours per day*
- What do you need to think about when designing the layout of your permagarden beds?
  - *What direction does the wind usually blow? Where does water, soil/nutrients flow when it rains?; How does sunlight move over the permagarden? (situate beds east to west layout if site is relatively flat, and along the contours if moderately sloped or more); bed size*
- How do you control the water?
  - *Understand that water always flows downslope. Consider the movement of water through your permagarden and place berms and swales along the upslope edges, perpendicular to the flow of runoff to slow, sink and spread the water, redirecting it underneath or around your beds.*
- How big should the permagarden and beds be?

- The size of the permagarden depends on how much space you have or how much you want to dedicate to growing vegetables for your family and for market. A good size to begin with might be 10m x 10 m.
- Permagarden beds should generally be about 1m wide, and separated by about 60cm between beds and 1m between rows. Bed lengths of 4m allow for easy movement around the beds.



Step 1: Draw bed layout and earthworks

**To do:** Now give the participants some time to draw the layout of their permagarden in their workbooks or on flipchart paper. Ask them to draw one arrow in the top corner of the piece of paper to indicate North. Then ask them to draw arrows showing the direction that the water flows. Once they have done this, have them draw the layout of berms and swales, then finally the beds.

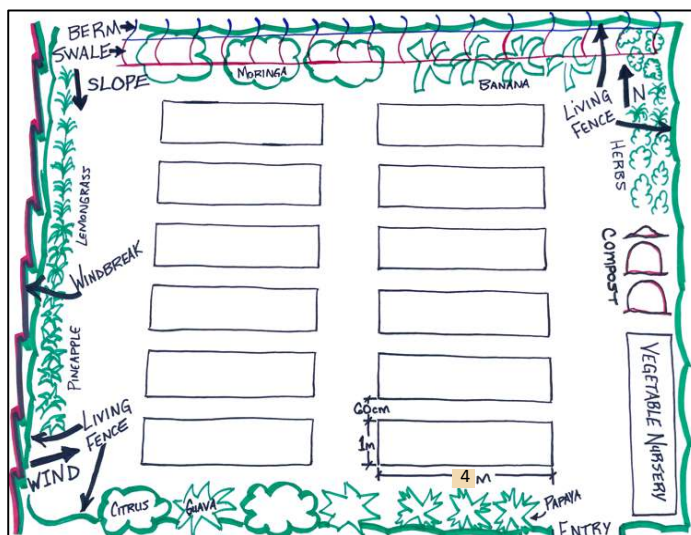
## Step 2: Borders and Alleys

The next step in the design process is to think through what you want around the borders of your permagarden. Borders and alleys should be designed to segment and protect your permagarden from pests as well as erosion.

You will also design your market gardens and field or tree crop areas that are not planted in beds. Use these same permagarden design principles anywhere in your Forest Garden!

- What are the benefits of planting along the borders and alleys?
  - Intensify/maximize production; protect the garden from wind and erosion with a living border of shrubs or grasses; trap or deter pests; attract pollinators and pest predators; provide nitrogen fixation and green manure, etc.
- What types of plants are good for borders and alleys?
  - Permanent or semi-permanent perennials; Grasses like vetiver are great for erosion and protection; small trees and shrubs can provide nutrients for the soil, shade, fruit, or other forest products; taller trees can serve as wind breaks; herbs, berries, and other perennials can provide nutritious and tasty foods to improve household diet and nutrition.

- *Specific plants might include papaya, pineapple, sugar cane, moringa, banana, citrus and other small fruit trees, and small perennial herbs like lemongrass.*
- How does sunlight factor in when planting borders and alleys? How will it change over time?
  - *Refer to pictures showing permagardens in different stages. In hot, very sunny areas they can allow thinly crowned trees and shrubs to grow and provide light shade; in areas that need more sun, they should manage their planting and pruning of trees and shrubs to ensure the site receives enough sunlight when it is needed during the year.*
- How does segmenting your field with living borders and alleys help your Forest Garden?
  - *Segmenting your field with borders increases protection throughout your Forest Garden and also makes it easier for crop rotation and relay planting (which will be covered later)*



Step 2: Draw Borders and Alleys (where relevant)

**To do:** Ask the groups to draw the borders, alleys, or segments on their design. Ask them to think about and write down the names (or draw pictures) of three to five things they would plant in their borders, alleys, and around segments in the Forest Gardens. Think about trees, shrubs, grasses, or other perennial plants, discussing why those would be beneficial.

They will put their design aside in the next few steps to think about bed layout with their group members, before completing their designs at the end of this activity. They can write them in their Farmer's Workbooks.

### Step 3: Food for the Family

Now it is time to think about what you will plant in your beds, alleys, contours or segments. You will focus on crops that grow in the main gardening season. A useful way to begin is to start with 'anchor' crops. An anchor crop is a main crop you will grow in a bed, alley, or segment. This is the priority crop you select for this area that will feed your family – either directly as a nutritious garden crop or indirectly as a market crop. In subsequent steps you will build your



design around these anchors. Different sections (i.e. beds, alleys, contours or segments) will have different anchors. It is important to design each section separately.

### ***What Anchors will you grow?***

Recall the vegetables you and your families prioritized for family nutrition and for market (*these should be written in the Forest Garden Planning workshop section of their Farmer's Workbooks*). Remember that healthy permagardens and healthy families center around diversity, in colors and types of vegetables and fruits.

It is good practice to select a mix of early maturing vegetables (e.g. dark leafy greens, tomatoes, cucumber, peppers, etc), semi-annual vegetables (e.g. beans, squash, pumpkins, gourds, eggplant, okra, garlic, onion, ginger, etc), and annual vegetables (e.g. sweet potato, cassava, pigeon pea, etc). This will ensure you have productive crops throughout the year.

### ***Where will you get the seeds?***

Be sure to consider where you will get the seeds you will be planting. Keep in mind that open pollinated varieties (OPV) of seeds are preferable, as you can save and replant them the following season, or trade with other farmers for different types or varieties. TREES will provide some seeds, but farmers will need a plan to obtain the other diverse seeds they need on their own.

- Ask a few volunteers to tell you different products they have in mind as anchors, and why they have selected these.
- Where will they get seeds for these? What types of seeds can/should they get?

### **To do:**

1. The Facilitator will tell the group which types of seeds TREES will be providing to farmers. Have them write this down in the appropriate section in their Farmer's Workbooks (if they cannot write, they can draw a picture or ask someone to help them).
2. Next, with each participant having reviewed their lists of vegetables their families have prioritized, ask them to write down or draw an image in their Farmer's Workbooks of five permagarden crops they will use as anchors to begin with. These can be crops for their permagarden beds, in alleys, along contours, or in segments.
3. Next, ask each group to select an anchor product that they chose in common, or that TREES will provide.
4. Ask each group to draw a top view map of a bed or alley, where they will practice creating a design of a given section or bed following these permagarden design steps
5. Now ask them to draw a top view of the anchor crop plants across the section, paying attention to the size/scale of the plants' crowns, as well as proper spacing with regard to size and scale. The Facilitator will draw a similar map for a select product as s/he goes through the steps.

## Step 4: Food for the Soil

Inform the participants that, after selecting anchor crops that ‘feed themselves’, they need to think about how they will ‘feed the soil’.

- Who can tell me what it means to ‘feed the soil’? Why is soil health so important for healthy plant growth?
- What can we plant in or around our permagarden beds to ensure healthy soil?
  - *Answers should include: planting nitrogen fixing plants, diggers and miners; using mulch and cover crops; The Facilitator should have a list of locally available plants that serve these purposes.*
- How else can we feed our soil?
  - *Encourage discussion around double digging beds, soil amendments and composting.*
- What are some ways we harm our soil?
  - *Chemical pesticides and fertilizers damage the soil; leaving soil unprotected leads to soil drying and erosion; tilling the soil damages soil structure/tilth.*

### To do:

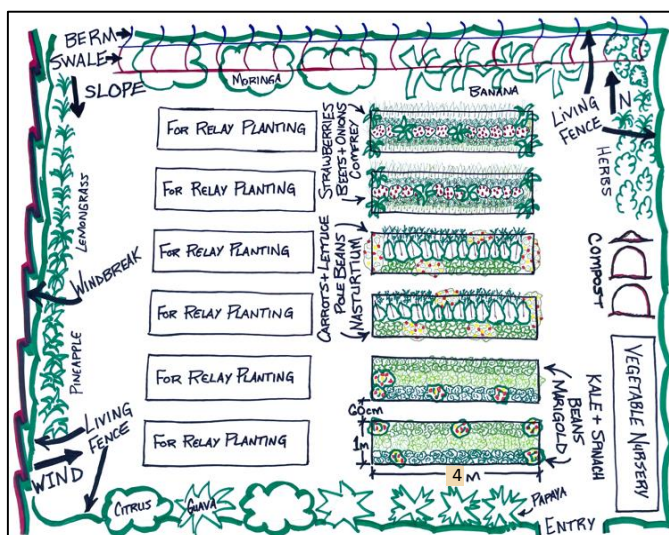
1. Have the groups think about plants they can add to the maps of their beds or alleys to feed the soil. Have them draw these plants in or around their beds or alleys. Legumes might be dispersed throughout, where diggers, miners or perennials might be placed on the ends, rows between, or edges, for instance. The Facilitator will do the same on her/his map.
2. Encourage farmers to review their priority list of foods for nutrition or market. If they have legumes included on their lists then they should include these as either primary or secondary crops in their designs. Inform the groups that they will also be adding in other companion crops and plants next, so to leave space for those.

## Step 5: Finding Companions

After feeding the family and the feeding the soil, the final step is to think about how to select companion plants to diversify the beds and protect your anchors. It is good to select multiple companions for a given section. You want to have one or two nutritious food or market crops that are secondary to your anchor crop in the section. You also want to identify companions that will protect your food or market crops. These may be planted in the same bed or alley or along the edges and along borders.

- Can anyone tell me what ‘companion’ plants are?
  - *Different plants that can protect or otherwise compliment one other when planted together.*
- Who can give an example of how one plant can protect or compliment another?
  - *Prompt responses and lead a discussion around the following benefits companion plants provide:*
    - i. *They grow well with anchor crops and provide secondary production of nutritious or marketable products.*

- ii. *Plants with diverse root systems or crowns occupy different layers of space below and above ground, so compete less for nutrients, water, and sunlight.*
  - iii. *Plants that require different nutrients reduce competition for nutrients in the soil.*
  - iv. *Shade-loving plants grow well under taller plants.*
  - v. *Aromatic plants with strong smells help to deter pests from non-aromatic plants.*
  - vi. *Pollen and nectar from flowering plants can attract beneficial insects that eat pests off another.*
  - vii. *Plants that attract and 'trap' pests can pull pests away from your anchor crops.*
  - viii. *Tall standing plants (e.g. maize or sunflowers) can serve as trellises for climbing plants and vines.*
  - ix. *Tall plants can provide shade for shorter shade-loving plants while taking up different layers of space.*
  - x. *Some plants can improve the flavor of nearby plants*
- What are our main garden pests here? What crops do they attack?
  - What are beneficial insects? Which plants attract beneficial insects or pest predators?
  - What plants can help protect our crops and manage our pests? Which plants should we plant them next to?
  - How far should we plant them apart from those plants?
  - How many should be planted in the beds or nearby?



Steps 3-5: Design and draw beds with anchors, food for soil, and companions (this can be done separately where preferred)

**To do:** After this discussion, have the groups to go back to their top view maps of the sections they drew. Ask them to now fill in the empty spaces with different types of companion plants. The Facilitator should hang up or hand out lists of common local crops and companions for reference.

1. *Companions for nutrition and market:* Have the farmers review their priority lists of nutrition and market crops again. Encourage them to find companions from their list to plant with their anchor crops.
2. *Companions for protection and support:* Next have them select plants that deter pests, attract beneficial insects, support other plants, and/or take up different layers of space, above and below the soil.

While the groups are drawing their maps, the Facilitator should complete his/her map, then walk around the groups to provide support and answer questions.

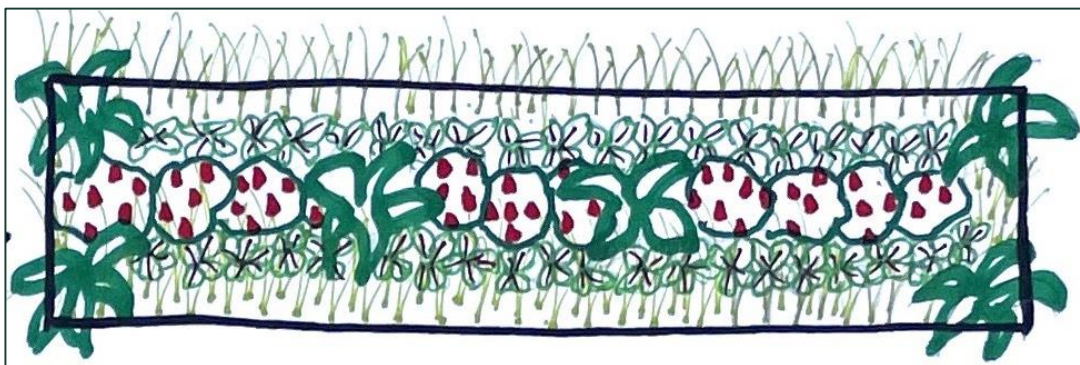
### Map-sharing:

After the groups have completed their bed or alley designs, ask them to each select a representative to present them. The presenter should note what they selected for the different steps, and how the different plants complement each other, as well as the border and alley plants they selected. After brief Q&A for each, ask them to hang the flipchart somewhere where everyone can see it.

### Completing Individual Designs

Finally, ask the group members to return to their group areas where they will complete their top-view maps of their own permagardens in their Farmer's Workbooks. They should already have the berms, swales, contours, and beds drawn. Now, using the different groups' bed or alley maps to stimulate their creativity, they should design three different beds around each of the three anchor crops they selected in Step 2, then filling in the companions. They should draw different sized circles on the beds with names or drawings to denote the different plants and their relative sizes. The variety of colorful and diverse anchor and companion crops included should meet the purposes of:

1. Borders and Alleys
2. Food for the Family
3. Food for the Soil
4. Finding Companions



## **Activity 2: Establishing the Permagarden (1 hour)**

### **Description**

If planned correctly, permagarden beds only need to be established once. Though more can be added as needed. After the location is identified, the farmer carefully plans and establishes soil and water conservation measures to protect double-dug beds. A vegetable nursery bed can also be established nearby to provide seedlings for select crops. After the heavy dirt work is complete, they only need to be maintained from year to year to establish a biointensive and highly productive permagarden.

### **Instructions**



This activity will take place around the host's permagarden site. This should be pre-identified based on the host farmer's Forest Garden design. The activity starts with participants observing the gradient and orientation of the site, discussing considerations with regard to water management and redirection, and mapping out where to place berms, swales, and beds. The Facilitators will then explain how to establish berms/swales, double-dug beds, and nursery beds. They will then split up into three groups and volunteers will take turns digging and establishing an example of each.

It is important that the Facilitator discusses safe use of tools with participants before using them. Participants should be sure no one else is near them when using tools and should use them safely to avoid any injuries.

### **1. Walk-through and Discussion**

The Facilitator will gather the group together to discuss the important considerations around the layout of the permagarden. Ask the participants to walk around the site and to think about and respond to the following questions:

- Does this site receive sufficient sunlight throughout the day? If not, how can we control or manage the available sunlight?
- Is it sufficiently protected (from animals, wind, etc)?
- Where will the water flow when it rains? What are the primary and secondary slopes within the site, if any? Are there any nearby structures or uphill drainage points where we can redirect water into the site if needed?
- When might you want to direct water away from your garden? When might you want to redirect it into your garden?
- How should beds be oriented to reduce erosion?
- How can we slow, sink, and spread runoff throughout the site?
  - *Discuss berms, swales and other relevant earthworks, or contours where needed*
- How should you maintain earthworks throughout the year? How can you stabilize them?
  - *Be sure they understand that earthworks should be built up after heavy rains to maintain them, and that berms can be planted with perennials to stabilize them and enhance erosion control.*

### **2. Earthworks & Beds**

Next, the Facilitator will help participants decide how and where to orient the earthworks and beds.

- Where will the water enter the permagarden? Where should we establish earthworks to slow, sink, or redirect it?
- How do you establish berms and swales? How wide should they be? How deep or tall? Should they follow the contour? On sloped land, how do we find the contour?

**To Do:** Using sticks, have them mark the locations of each as they agree on them

- How should we orient the beds? How many should there be? What size?
  - *Be sure they are considering the movement of the sun and shade, both presently and as the permagarden matures*
- How far should they be from the Green Wall or other nearby trees? Can anything be planted in beds that are shaded by trees?
- Is the site large enough to allow for segmenting and alley crops? If so, how would they be laid out and planted? How does segmenting help with crop rotation? Pest control?
- Should the beds be sunken or raised?
  - *Beds should be raised when there is a need to prevent water buildup on top of beds; they should be sunken in places with little rain, to direct water to the crops and to penetrate into the soil.*
- Who knows what double digging is? How does it improve drainage? Root growth? Fertility?
- If you are only doing a few double dug vegetable beds this year, which crops should be planted in them? (target high value, needy crops for this location and the rest in other deep dug beds)
- How do you add amendments to the soil when double-digging? What amendments do you use?
  - *Always add compost! The more organic matter and nutrients you add to your beds, the healthier the soils, the better the structure, and the better the yields will be.*
- What should the soil look like when finished?
- How do you estimate meters without a measuring tool, in order to layout your beds?

**To Do:** Have participants place sticks in the ground to mark the corners of the beds, and draw lines with sticks across the ground to demarcate alleys.

### 3. Vegetable Nurseries

After the earthworks and beds are marked in the site, the Facilitator will discuss vegetable nurseries:

- Who has experience raising vegetables in a nursery? What did you grow and how did you do it?
- What are the reasons for growing vegetables in a nursery?
  - *Easier germination and management, Give the plant a “head start”, Protect the young plant from damage.*
- How is the vegetable nursery different from or similar to a tree nursery?
- What should you look for in selecting a vegetable nursery site?
- Is there a difference between preparing beds for a vegetable nursery and for the permagarden bed? What should the beds look like? How big should they be?
  - *Nursery beds do not need to be double-dug but they should be loosened and amended with compost*



- Is there anything extra you should do to prepare the soil for a vegetable nursery?
- How do you protect the vegetable nursery? from damage? From sunlight?
- Which plants would you start in the nursery? Which would you plant directly in the garden? What does **direct seeding** mean?

**To Do:** Ask participants to identify a good site for the vegetable nursery and mark the bed with sticks.

#### 4. Practice

Now the locations of earthworks, permagarden beds, and nursery beds should all be marked. Split the participants into three groups and give each group an assignment to either:

1. Dig/establish a section of berms/swales
2. Double dig a permagarden bed
3. Prepare a vegetable nursery bed

**To Do:** Have the groups take the tools they need, and take turns using them to establish their structure. Remind people to work in a safe manner, ensuring no one is near them before using tools. **The Facilitator should monitor the groups to ensure safety.** After a person has spent a few minutes with a tool, encourage them to walk around to the other areas and observe their work. Give them about 15 minutes to establish a section of each. It is not necessary to complete a full section or bed of each, but just to get an understanding of how it is done.

After 15 minutes, bring the groups back together to wrap up:

- Has everyone seen the different techniques? Does anyone have any observations or questions about any of them?
- How often do these need to be built/established?
  - *Only once if they are well protected and maintained, and the benefits continue to last year after year.*
- Understanding that these take a lot of work, and your permagarden site might be large, what happens if you are not able to complete the double digging of all of your beds this year?
  - *If this is the case, farmers should focus on the beds for their high value crops in the first year. They can use other techniques (deep digging, heavy mulching) on the rest. Then each year they can add more double dug beds.*

## Activity 3: Planting the Permagarden (45 minutes)



## Description

The Facilitator introduces planting techniques for different crops including direct seeding and transplanting nursery seedlings. Farmers share about those methods they already practice.

## Instructions

The Facilitator will split the participants into two groups for this activity. If there is a Co-facilitator, each will take one of the groups and one will cover direct seeding while the other covers transplanting, then they will switch. Next, one Facilitator will cover planting along alleys and contours while the other covers companion planting, then switch again. If there is only one Facilitator, then s/he should seek the Lead Farmer's support in splitting up the activities. Be sure in this case to prepare the Lead Farmer beforehand.

### 1. Direct Seeding

Take the group to one side of the site, away from the permagarden bed that was prepared. Have examples of seed varieties that they will be direct seeding this year. Pick an area where a handful of seeds can be sown as examples for the purposes of this activity. Instruct them how to plant the seeds, showing the depth, spacing and, where relevant, triangular spacing examples for each seed. Allow participants to practice sowing. Lead a discussion around direct seeding methods and considerations.

- How do you direct seed this type of vegetable?
- What is the spacing and planting depth for this seed?
- If it is sprinkled, how thickly should you sprinkle it? Do you cover it after?
- Should this seed be planted using triangular spacing? If so, how?
- What companion plants could you plant around these seeds? Where could you plant them? Why?
- Which vegetables should be direct seeded instead of started in vegetable nurseries?
- What other vegetables will you direct seed this year?
- How should they be planted?
- When should you plant them?
- What would you do differently when sowing your vegetable nursery bed versus direct seeding into beds? How does the spacing change? Why?

### 2. Transplanting

Using seedlings that were started earlier, and will serve as anchor crops in this activity, move the group to the prepared bed where you will demonstrate the proper way to transplant, including triangular spacing. Each group will practice transplanting the seedlings of the anchor crop provided. *Their companions will be planted in the following fourth section on planting companions.*

- Which vegetables are better to start in vegetable nurseries rather than direct seeding them?



- What is **triangular spacing**? How does it help to maximize the number of crops in the permagarden?
- How do you approximate spacing using your hands, arms, or pacing?
- How do you properly transplant seedlings?
- Why is it important to water after transplanting? How should you water and how much water should you give?

### 3. Planting between alleys and on contours

Take the group to the side of the permagarden site again. Tell the group that when you first begin establishing your permagarden, and Forest Garden for that matter, there will be a lot of extra space between alleys or along contours. There may also be segments of your Forest Garden that you will leave open for market gardening or field crops. Explain that we always want to consider how to maximize the use of space. In these spaces, and depending on the crops, it may be better not to use beds. In cases like this, it is not necessary to double dig the alleys or contours. Explain the process of growing vegetables in these spaces.

- Which vegetables might be best in alleys or contours, **not** using beds?
- Why is it easier to do transplants than direct seeding if planting in a large area?
- How do you plant on a grid? What is the spacing?
- Is there anything to improve the soil structure for these vegetables when not using a double dug bed?
- What is a zai hole and when are they useful? *Show them how to prepare one*
- What design steps did we learn today that are relevant for planting between alleys and on contours? *All of them! You can review them again here.*
- What other permagarden principals have we discussed that are similarly beneficial when planting on alleys and contours?
- How do you protect your soil in the dry season, if you aren't able to irrigate or grow crops? *The use of cover crops protects the soil during the dry season and can cut and mulched in the next cropping season.*

### 4. Planting Companions for IPM and other needs

At the bed where transplants were just planted, now give participants in the group 1-2 companion plant seedlings or seeds to practice transplanting while discussing the following:

- What benefits do these companion plants provide to the anchors we just planted?
- Where should we plant them in relation to the other plants in the bed? How far apart?
- Which plants are good for planting along alleys and borders?
- How many should be planted in the garden?
- Which ones need to be started in the nursery?
- How long will they stay in the nursery before being ready to transplant?
- What kind of care do they need?
- Is it a perennial plant? If so, how does that factor into planning for this bed?

## Activity 4: Permagarden Maintenance and Care (30 minutes)

### Description

Bring the groups together again to finish up the planting activity by mulching beds, then transition into a discussion of maintenance and care of the permagarden.

#### 1. Mulching beds

As the beds are finished planting, have the group finish up by mulching each bed.

- What is mulching? Does anyone already practice mulching?
- How does mulching help conserve water in the soil?
- How does mulching help to limit weeds in the Forest Garden?
- What are some sources of mulch?
  - *Wood chips or sawdust from the farm or local carpenters; Fallen leaves and plant debris (be careful not to use materials from pest or disease affected plants!); Grass clippings or hay.*
- How should you mulch around transplants?
- How deep should the mulch be?
- Should you mulch beds over direct seeding of plants?
- Should you mulch vegetables when planted in a grid as well? Why?

#### 2. Weeding and watering

Demonstrate good watering practices while explaining how to water.

- How often should you water the permagarden?
- What time of day should you water?
- How much water should you give?
- Is it necessary to weed your garden? Why? How often?

Note: If farmers use drip irrigation, instruction on that can be inserted here.

#### 3. Crop rotation

One way to maintain fertility and mitigate pests and disease over time is through crop rotation.

- What is crop rotation?
- Why is it important for permagarden production?
- What crop rotations are you familiar with?
- How does crop rotation help improve soil fertility?
- How does crop rotation help reduce pests? What happens to pests when we plant the same thing in the same place multiple times in a row?

- If your crops are all mixed with different types together, do you need to practice crop rotation?
  - *Not if everything is completely mixed; crop rotation is more for blocks of vegetables when most of the bed is a primary crop*
- How do you know which crops to rotate?
  - *The easiest thing to remember for crop rotation is to go from Leaf to Fruit to Root to Legume, then back to Leaf*
  - *These similar plant types generally attract similar pests and take the same nutrients from the soil. Look at the crop rotation diagram in the Farmer's Workbook and think about what you planted in the same space last year. Was it a Leaf, Fruit, Root, or Legume? Then think about the type of crop you should plant next in that space.*

#### **4. Relay planting**

Relay planting (or succession or staggered planting) ensures a continuous supply of a crop(s) throughout the growing period.

- How is relay planting like a relay race?
  - *One person runs and gives everything they have, then hands a baton to the next person who does the same and continues this relay and handoff until the race is complete.*
- Why is it good to practice relay planting?
  - *It ensures that your permagarden provides a constant source of products throughout the growing season by planting one section with a crop, waiting for a period, then planting another. By the time one section has finished its production, another section will have already reached the production stage.*
  - *Doing this with a mix of early-maturing, semi-annual, and annual vegetables will ensure your permagardens remain productive throughout the year, and extending the growing cycles of all of them.*
- How do you do it? When?
  - *Plant one section (bed(s), alley, etc) and leave another empty. After a period of time plant the next section. The amount of time between planting depends on the productive life of a given crop (i.e. how long the crop will produce in one cycle, or the amount of time you expect it will take to consume and sell the crop you planted in the first section). By the time the productive life of one section is complete, you will have another section that is producing.*
- How much space do you need?
  - *This depends on the crop and how much space you need to produce the desired amount for the first cycle. You plant the first section for the first cycle then leave that same amount of space empty in preparation for the second cycle. If there is time in the growing season for more cycles, you could either plant that in the first section, or rotate to another section following the crop rotation schedule.*
- How do you plan for it?



- *Determine how much space you will need for one cycle and leave that same amount empty until you are ready to plant the second cycle.*

## Activity 5: Introduction to IPM (30 minutes)

### Description

The facilitator discusses natural pest management versus chemical pesticides. They practice making one natural pesticide together that can be applied to their fields.

### Instructions

#### 1. Introduce Integrated Pest Management

Lead the group in a discussion of IPM and how it might be applied in the Forest Garden.

- What is IPM?
  - *After defining it, inform them that IPM is not meant to get rid of all pests, but to control them and prevent large outbreaks*
  - *Be sure to discuss preventative IPM measures (diversifying production, using plants and smart design) as well as the use of IPM solutions, both as preventative measures and control.*
  - *Remind them that IPM solutions alone will not control pests once an outbreak occurs, so you need to control them from the start.*
- What examples of IPM have we already discussed today? Why is it important to consider how you will use IPM practices from the very start, in the design stage?
- What are some examples of IPM you have in the Forest Garden?
- Why are natural solutions preferable to chemical pesticide use?

#### 2. Learn to make an IPM natural pesticide

Introduce 1 recipe for dealing with the 1-2 most common pests identified by the lead farmer in preparation. Farmers spend 15 minutes creating the natural pesticide and practicing applying it for that particular pest and crop.

- What insect is this remedy for?
- How do you make this remedy? What ingredients are needed?
- How do you use it? How do you apply it?
- When should you use it? Is this remedy for prevention or control of pests?
- Are there any other remedies you know of that you can put into practice now?

Following the discussion, remind participants that they will practice IPM in more detail during an IPM workshop in Year 2.



## Take Home Activity Review: Establish your Permagarden (20 minutes)

### Description

Using the techniques learned in this workshop, farmers will design and establish their own permagardens and start their vegetable nurseries. They will also make one natural pesticide to use during the growing season.

### Instructions

The final step in this workshop will be to explain the take-home assignments. The Facilitator will make sure everyone is clear on the requirements, then will end the session after providing vegetable seeds that they will plant in their vegetable nurseries to farmers.

#### **1. Farmers construct permagardens**

Farmers will establish their 3 permagarden beds using correct bed dimensions, orientation, double digging, swales and berms.

#### **2. Farmers construct vegetable nurseries**

Using the techniques discussed in this workshop, farmers will construct their own vegetable nurseries and sow vegetable seeds correctly.

*After doing this, farmers will do the following at the start of the gardening season:*

#### **3. Farmers make a natural pesticide**

Farmers will replicate the natural pesticide recipe introduced in the workshop and make a batch for use in their permagardens. They will then apply it in their permagardens.

#### **4. Farmers transplant and direct seed vegetables and companion plants**

Using the methods taught in the workshop, farmers will direct seed and transplant vegetables into their permagarden beds. Using the companion groupings taught in the workshop, farmers will transplant or direct seed companion plants next to and around anchor plants for pest control and secondary production.

#### **5. Farmers plant their borders**

If they haven't already, farmers will plant their borders (living fences and windbreaks) around the permagarden area, per their designs.

### Follow-up



The lead farmer will visit participant farmers' Forest Gardens within 2 weeks to check on the garden bed and vegetable nursery establishment and within 8 weeks to check on the planting in the permagarden beds at the start of the gardening season.

## Permagarden Performance Measurement Checklist

**As a result of this training, *within 2 weeks* it will be observed that the farmer has:**

- ☐ Established a vegetable nursery bed
- ☐ Correctly sown seeds.
- ☐ Established 3 permagarden beds (double dug, sunken or raised depending on region).
- ☐ Established basic garden earthworks (swales and berms) around their permagarden.

***Within 8 weeks***

- ☐ Created and applied one natural solution according to what is identified in the field
- ☐ Successfully transplanted their anchor crops from the nursery
- ☐ Direct seeded anchor crops
- ☐ Sown or transplanted plants for the purpose of feeding the soil
- ☐ Established companion plant groupings for IPM and secondary production in each bed, for example:
  - ☐ Using one or more techniques to attract beneficial insects (flowers for pollinators; planting crops that tower high--sunflower, papaya--for praying mantis, birds and lizards; others?)
  - ☐ Planting one or more companion plants to repel insects (onions, desmodium, garlic, lemongrass, marigolds, other pungent herbs)
  - ☐ Planting one or more companion crops for secondary production
- ☐ Planted borders around their permagarden area.

## Composting

### Goal

Farmers learn to improve soil fertility by constructing and maintaining compost pits or piles in their Forest Gardens.

### Learning Objectives

*By the end of the workshop, farmers will be able to:*

1. Be familiar with the qualities and attributes of poor soil and good soil.
2. Understand the benefits of compost and the difference between compost and chemical fertilizers.
3. Select and prepare appropriate locations for composts in their Forest Garden, according to sun, moisture, and access.
4. Construct compost piles or pits with the appropriate materials and correct layering
5. Correctly maintain compost through turning, watering, and checking temperature.

### Venue and Timing

This module should take place in Year 1 and should be conducted early as possible in the program cycle year to accelerate the availability of mature compost. It should take place during a season when there is adequate availability of green and brown material.

### Relevant Technical Manual Chapters

- Chapter 14: Compost

### New Concepts and Vocabulary

Facilitators should prepare these words and concepts ahead of time so they know how to accurately describe these things in local and appropriate language, during the course of the activity.

- Nutrients
- Organic matter
- Compost
- Aeration
- NPK
- Microorganisms
- Green fertilizer
- Nitrogen fixing
- Soil amendments
- Activator

## Preparation

- Decide ahead whether farmers will be learning to construct pits, piles or both.
- Collect soil samples that represent weak soil, rich soil, and any other types relevant to the zone (clay, sandy, silty).
- Ensure that the compost materials in appropriate quantities are prepared at the host farm.
- Remind farmers to bring their Forest Garden Designs
- In dry regions, Lead Farmers can pre-dig the pit to save time (be sure it is placed according to location considerations)

## Supplies

- ☐ 1 bucket sample of “weak” soil and 1 bucket sample of “good”, rich soil for participants to pass around and feel and any other types relevant to the zone (clay, sandy, silty).
- ☐ Clear containers for each type of soil listed above--(1.5 L bottles are good) with the bottom cut off creating a funnel.
- ☐ Sufficient, locally available materials for composting activity--3-4 parts brown material for every one part green material..
  - ☐ “Brown”, Carbon-rich material (for example: dried leaves, dried grass, peanut shells, corn/millet/sorghum stalks)
  - ☐ “Green”, Nitrogen-rich material (for example: green leaves; green grass; vegetable scraps)
  - ☐ “White/Grey” compost enhancement materials (wood ash, eggshells, as available)
  - ☐ “Black” charcoal to conserve moisture in arid areas
  - ☐ 1 bucket of manure, fertile topsoil, or finished compost as source for bacteria
  - ☐ At least 60 liters of water
  - ☐ 1-2 wheelbarrows for moving compost material
  - ☐ Spade, hoes, or pitchforks for turning compost (enough for each small group)
  - ☐ 1 watering can to water the pile
  - ☐ 3-4 Machetes or pruning implements to cut plants for use in the compost.
  - ☐ 1-2 buckets of finished compost for application to 6 areas (2 young trees and 4 vegetables)
  - ☐ 2 1.5 liter bottles with bottom cut off for funnels
  - ☐ 1 - 3m x 3m old plastic sheet, if available, or banana leaves to serve as a moisture barrier.

## Total Time

Approximately 2.5 hours



## Composting

### Summary of Activities

**Opener:** Name that Soil (30 min)

- Weak soil
- Healthy soil
- Benefits of composting

**Activity 1:** Selecting Locations and Collecting Materials (20 minutes)

- Best location of a compost
- Materials of a compost

**Activity 2:** Constructing a Compost (45 minutes)

- Digging pits for compost
- Preparing the site
- Layering and building compost

**Activity 3:** Maintaining and Using Compost (30 minutes)

- Maintaining compost
- Using compost

**Activity 4:** Review and Workshop Closure (15 min)

- Review workshop activities
- Participants evaluate the workshop
- Assign take home activity and paired Forest Garden review



## Opener: Name that Soil (30 minutes)

### Description

The facilitator introduces the workshop by explaining why farmers should create compost, and farmers discuss the difference between weak and healthy soil through touch and observation of soil samples.

### Instructions

#### 1. Weak Soil

Gather the farmers in a circle around multiple piles of soil representing 1) weak soil that farmers have in their fields, 2) rich soil that has been improved with composting, and 3) any other samples of soil types, such as clay, silty, or sandy soil that farmers may see in their community. Begin a discussion of what people observe in soil and how they know soil is weak or tired.

- Why is soil fertility important?
- What are the challenges you have seen with soil fertility in your region?
- What techniques do farmers do that hurts the soil and reduces soil fertility?
  - Does chemical fertilizer help improve the soil? Why or why not?
  - What is the effect of burning and clearing fields with fire?
  - How do techniques such as plowing and pesticide use also damage soil?

Invite everyone to take a handful of the weak soil in their hands and any other local samples they should examine. Ask a series of questions around characteristics of weak soil.

- How can we tell when the soil is exhausted or not performing well?
- Look at the soil closely. What do you observe?

Have everyone take their small handful of the weak soil and wet it, and try to form it into a ball in your hand.

- Does it hold its shape or fall apart? (sand will fall apart, clay, loam, and silt will stay in a ball)

Pour water into one container holding the weak soil (and any other soil samples you are working with) and allow everyone to observe what the water does.

- Does the water flow straight through the soil? How long does it take for it to go all the way through?
- Does it pool on top? How long does it take for it to soak in?
- What would be best for plants when thinking of water flowing through and soaking in?



## 2. Healthy Soil

Invite everyone to take a handful of the healthy soil in their hands. Ask a series of questions around techniques that improve the soil.

- What soil fertility improving practices have you used or seen being used? What has been successful?
- What are some techniques we use in the Forest Garden to improve soil?
  - Fertilizer Trees (Alley Cropping, Contour planting, Green Wall)
  - Green manure
  - Crop rotation
  - Mulching and cover crops
  - Composting
- Looking at the small handful of healthy soil, wet it, and try to form it into a ball in your hand. Does it hold its shape or fall apart?
- What does it look like and smell like?

Pour water into one container holding the healthy soil and observe what the water does.

- Does the water flow straight through the soil? How long does it take for it to go all the way through?
- Does it pool on top? How long does it take for it to soak in?
- How is this different than the weak soil? Which would be better for plants?

As a large group, continue looking at the soil samples you are holding, especially the one that is most healthy ("good soil" or loamy soil).

- We can see different different colors and feel different textures of soil and of soil particles. Is there anything else that contributes to soil being good or healthy?
- Do you see any bugs in the soil? What kind of life is in the soil?
- What is in the soil that we cannot see? (Soil is home for living creatures, some of which are invisible--**microorganisms**).

Explain how organisms help create a good environment in the soil and why it is important to encourage their growth.

- How do these living creatures/**microorganisms** help the soil? (Similar to a cow that eats plants and makes manure, microorganisms eat plant material and make nutrients available to plants).
- What might harm these organisms? (Chemical pesticides and fertilizers)
- How might we introduce and encourage these soil organisms to the soil in our Forest Gardens? (Animal manure, Compost tea process, Soil that has already been enriched, and mature compost can all inject/activate the compost with good microorganisms).

## 3. Introduction to Composting

Gather the group together in a circle and introduce the conversation of composting to the group. Ask if anyone has experience making or using compost. Share how compost is an essential part of any healthy Forest Garden and that the many benefits it provides makes it one



of the most important and essential components of your permagarden as well as your Forest Garden helping to grow healthy, nutritious and marketable crops.

That's why today we are learning to make **compost**!

- What is composting?
- Who had experience composting?
- How does composting improve the soil?
- What are some of the many benefits of using compost in your Forest Gardens? (improved crop yields, healthier plants, compost makes the gardens more drought tolerant and pest resistant, increases water holding capacity, soil structure)
- Is compost the same as other fertilizers? How is it similar or different from NPK, DAP (or other major fertilizers)?

## Activity 1: Selecting Locations and Compost Materials (20 minutes)

### Description

The group discusses characteristics of an ideal compost location and small groups work to identify potential good locations for composts. Following this, the group looks at example brown, green and grey/white compost materials and brainstorm possible sources of these categories.

### Instructions

#### 1. Criteria when selecting compost locations

"Now that we know why it is important to create compost, we need to select the perfect location to set up a compost pile or pit." Ask the group the following questions to prepare a small group activity.

- What should you look for in a good compost location? (shade, access to water, adequate space for piling materials and working, proximity to where the finished compost will be used)
- Why is it important to have multiple locations throughout a Forest Garden? What are some reasons why farmers may want to have the composts on different sides of the field?
- Why might they want their composts next to each other?
- How many compost areas will you create in your Forest Garden? Why? (the requirement is 1 in the first year and a second in the 2nd year, but farmers are encouraged to do more than this).



## 2. Small groups identify a good location for the compost area

Divide the group into small groups of 4-5 and have each group select a location on the host farmer's field that they think is ideal for composting. Once they have selected a couple locations, have each share their ideas. Ask the owner of the field to help finalize what he or she plans to do based on the ideas gathered.

- Looking at your Forest Designs, how many composts did you choose to make, and where did you place them?
- Where is the best location in the Forest Garden for the compost piles/pit?

## 3. Materials needed to make compost

How do we get started? Let's look at the materials you will need to build compost piles/pits. Divide the group into four small groups and have all the groups stand in a semi-circle around the material piles. Refer to 3 pre-prepared piles of compost input material, introducing each type of material and discussing what could fall under each category of brown, green, and white/grey.

- What are three key elements of any compost?
  - Brown/Carbon, Green/Nitrogen, and Grey or White/Other
- What are some examples of carbon-rich (brown) materials? Where can you find them? Have the group list locally relevant sources of carbon (dry leaves, peanut shells, chaff or husks, soil, etc.)
- What are some examples of nitrogen-rich (green) materials? Where can you find them? Have the group list locally relevant sources of nitrogen (green leaves and weeds, manure, food scraps, etc.)
- What category is manure in? Manure is also considered in the Green category as it is high in nitrogen, though it may be varying colors. It is a good "**activator**" to activate the compost with good microbes.
- Are there any other activators if manure is not available? (Forest topsoil may occasionally be added to provide a microorganism source, but should be used carefully and sparingly so as not to damage the local forest ecosystem. Compost may also be activated through the addition of manure or finished compost from a mature pile or pit.)
- What kind of things fall under the grey/white category? (charcoal, ash, bones, eggshells)
- What do these things add? (other nutrients, water absorption ability)
- Is it possible to use any of these things on their own, as amendments without composting and just apply them directly? (manure, eggshells for calcium, bones, ash, etc)

Demonstrate how to chop materials into smaller pieces and have group members practice while continuing the discussion. Remind farmers about safety concerns to ensure no one gets hurt during this chopping activity.

- What size pieces do we need to chop the brown and green materials into?



- Why do we need to chop them up?
- What other materials need to be added to compost?
  - Water: The compost will need to be moist to facilitate decomposition and bacteria growth.
  - Air (this is added by turning which will be discussed later)
  - Microorganisms: The facilitator should quiz the group to list locally relevant sources of microorganisms shared from the first activity (compost or compost tea from another pile/pit, forest soil, manure, etc.)
- What materials should you avoid adding to your compost? Why?
  - Meat and animal products besides manure should generally be avoided. Egg shells and fish scraps can decompose in active composts and provide good nutrients, but working with animal products in compost brings challenges.
  - **Warning:** Never use any plant material that has been infected by disease or pests.

## Activity 2: Constructing the Compost (30 minutes)

### Description

Regional differences in rainfall, wind and humidity will influence whether farmers create compost piles, pits, or both. If in an arid region where pits are used rather than piles, the group will look at a pre-dug pit and discuss the requirements of digging a pit. If in a humid region, the group will do step 2 instead, preparing the ground for a pile. Either way, there are many similarities in what is used and how they are layered to get the compost activated. All groups then do step 3, in which the facilitator leads the group in the process of building compost through layering (either in pits or piles), making one or several composts at the training venue. Before getting started, remind all participants about the safety measures that should be taken when handling tools.

### Instructions

#### 1. Digging a Compost Pit

In dry areas, compost is best made in pits to conserve water. For these regions, the group will have the added step of digging a compost pit which can be quite labor intensive. To save time, the facilitator may ask the Lead Farmer to prepare all or some of the pit ahead of time.

- Why do you dig a pit?
- What should the dimensions of the pit be?
- When should you dig the pit in preparation of your compost?
- How many pits should you dig?

#### 2. Preparing the Area for a Compost Pile



Now that we know where we want to do the compost, we need to prepare the area. For farmers who plan to create a compost pile, ask a series of questions to think about moisture and aeration.

- How big should the base or footprint of the compost be?
- Why might the farmer want to cover the ground beneath the compost with a barrier of banana or other leaves (or even place the compost on a cemented area)?
- Why might the farmer want to line the ground with larger sticks to raise the first layer of the compost off the ground? (Aeration helps things decompose faster.)

### **3. Building Compost through Layering**

Now we will practice layering compost. We have the materials needed to build the first compost here. Let's practice layering the materials together.

- How much of each element do we add to each layer? How many fingers, (or cm or wheelbarrows/buckets) of each type of material should be in each layer?

Add 3-4 "fingers"/7-8 cm of brown

- What are some things that are in brown? Where can you get them? What other brown can you use?
- What layer comes next?

Add 1 "finger"/2.25 cm of green

- What are some things that are in green? Where can you get them? What other green can you use? What about the activation (manure)
- What layer comes next?

Add in the manure activator

- Where can you find manure? Is it easy to find?
- Are there things to watch out for in using manure?
- How do you properly age manure?
- If you have trouble finding manure are there any alternatives?
- Can you use urine?

Add the grey/white and black

- What can be added for grey/white?
- What is the black?
- How much should you add? (not more than 1 finger per layer)
- What if you do not have enough of this?
- What does it contain? (calcium--bones, eggshells; potassium--ash)

Watering the compost

- How much water should you give it for each layer?
- Can you just water at the end instead?

Repeat the layers and continue discussion through each layer. Farmers can accelerate composting in piles by learning to include a pole or stick that encourages the flow of air, moisture and nutrients throughout the pile. As soon as the base is high enough to support the



pole, insert the large stick down the middle of the compost and continue adding layers around it.

*Note: If some materials run low during this process, send small groups out to collect more from the field while the rest of the group continues to layer.*

- What happens if you have too much brown? (slow decomposition) Add more green
- What happens if you have too much green? (smells bad) Add more Brown
- What happens if you do not have white/grey materials? (it is not the optimum but you can still make and use this compost)

Complete the layers when they have reached the appropriate height.

- How high should the completed compost pile/layers be? Why?
- How much do you water at the end?
- Why is it helpful to cover the compost with banana leaves, plastic or other wide materials? Is it necessary?

## Activity 3: Maintaining and Using Compost (30 minutes)

### Description

When the group finishes layering the compost pile up to a height of at least one meter (or when they finish filling in the pit), they discuss the steps required to maintain a compost pile or pit, including turning and aeration and problem signs they might experience. They then talk about when it will be ready to use and practice applying finished compost to the vegetable plants in the garden.

### Instructions

#### 1. Maintaining Compost

When finished layering the compost, lead the discussion as a large group about management practices of a compost, including the process of turning/**aerating** and watering the compost.

- Once the compost is built, how do you know if it is working?
- Why is it good for the compost to get hot?
- Why do you need to keep your compost moist and aerated?
- When will you turn the piles/pit layers? Why?
- How often should you add water? How do you know if the compost is too wet or too dry?
- What should you do if the compost is too dry? Too wet?
- If the compost is not getting hot, what might the reasons be? What should you do to remedy it?
- What are some signs the compost needs more maintenance?
- What is wrong if the compost smells bad?



- How do you make sure there is adequate air flow?
- How might you manage the compost differently in the rainy and dry seasons?
- Is there anything you can do to influence the speed of the decomposition process?
- How can you check to be sure your compost is decomposing? When can you start checking the stick?
- What three things related to smell, temperature, and moisture are you looking for when using a stick to diagnose the state of your compost?

## **2. Identifying “Mature” or “Finished” Compost**

Take some finished/mature compost and pass it around to show the group what it will look and feel like when it is mature.

- How do you know when your compost is ready for use?
- What does it feel like, look like, and smell like when it is finished?
- If you turn the compost regularly how long will it take to produce mature compost? What about if you just layer it and leave it?
- Why is it good to have multiple composts at any given time? (so that you always have some compost ready to use, for a continuous supply of free, nutrient-rich, organic fertilizer)
- Is it okay to put compost that is not fully decomposed around your plants? (No – if it is still decomposing, the compost could burn, stunt, or kill your plants. This is similar to putting fresh manure around your plants and it will do the same damage)

## **3. Using Compost**

As a group, walk to a location near the permagarden area and young fruit trees. Demonstrate how to apply compost to one of the plants in the permagarden.

- Where should compost be added to your Forest Garden? (everywhere, but particularly around your high-value food and market crops and also in your tree nursery soil mix)
- Which high value crops or trees do you want to target with compost ? (crops that require a lot of nutrients, crops that bring in a lot of income, young expensive trees)
- How do you apply finished compost to the plant in the garden? Where do you apply it?
- How much should you apply to each plant?

Demonstrate applying compost to a young tree, placing compost in the cuvette area and mulching on top of it.

- How do you apply compost to a tree that is already planted?
- How much should you apply to each tree?
- When you are planting fruit trees, where do you put the compost? (in the hole, but above the planted tree not below it)
- Why is it less necessary to apply it to older, mature trees?
- What happens if you leave compost on the surface of the ground?



- How often should compost be added to the trees, vegetables, and other crops in your Forest Garden? (prior to the growing season for each crop)
- How would using mulch with composting be helpful? (prevent it from blowing off or washing away, so ensures more of it can enter the soil and be accessed by the plant)

After demonstrating, have the group divide into smaller groups to apply small amounts to 4 different plants or areas of the permagarden and/or young fruit trees.

## Activity 4: Workshop Closure and Forest Garden Design Review (15 min)

### Description

After learning to apply compost in the field, the group reconvenes in a large circle for final review of the day's workshop. After being assigned their take home activity, they break into pairs to plan their compost piles/pits.

### Instructions

#### 1. Review workshop activities

Regather as a large group. Take participants' questions and address any concerns they may have while checking for understanding.

- What are the benefits of using compost over chemical fertilizer?
- What are the considerations you should think about when selecting a location for your compost?
- What is the ratio of brown to green materials for layers in your compost? (how many fingers of each?)
- What do you need to do to manage your compost once it is built?
- Do you feel comfortable making your own compost?
- Is there anything we reviewed today that is unclear? What questions do you still have?

#### 2. Participant evaluation of workshop

Briefly ask participants these questions to evaluate the success of the workshop and identify areas for improvement.

- What was the best/most important thing you learned in the workshop today?
- What could be improved? Any other suggestions?

#### 3. Assign take home activity and Forest Garden Design Review



Explain the take home activity and have farmers divide into pairs, to share with each other their next steps for establishing compost in their home fields. Earlier in the program, each farmer selected a couple locations to place their composts. This is a final check that the preselected locations are good, based on the day's workshop and each farmer should identify the locations on their Forest Garden design and confirm the location or select and mark a new one based on what they learned today. Have pairs discuss the following questions and visit each group as they are working to provide support.

- Will the locations you selected at the beginning of the program still work as good locations based off of what you learned today?
- Is that where you will keep them or will you update your map? Why have you selected this placement?
- Where are the locations of your Forest Garden that have the lowest soil fertility?
- Where will you first apply your compost?
- How many compost piles or pits will you start with? (minimum 1)
- What materials do you plan to use for each of the colors?
- Do you know where you will get the materials needed? Are there any materials that you think will be challenging to find?

## Take Home Activity: Make Your Own Compost

### Description

Each farmer will prepare 1 compost pile or pit for use in their Forest Gardens at home. A second one will be added in the second year. (Farmers are welcome to do more than the required amount if they choose)

### Instructions

#### **1. Make a compost in your forest garden**

Using the techniques learned in today's workshop, farmers will create at least 1 compost pile or pit for use in their Forest Garden. Participants should be instructed on the recommended size of the compost and each should utilize the same materials used in the workshop.

### Follow-up

The lead farmer or technician will visit the farm in the next two weeks to make sure the compost has been made, or the farmer will send a photo of the completed pile/pit to the technician if in a region with smart phone use. The technician or lead farmer may consider visiting just before planting season to ensure the compost is properly being used.

## Composting Performance Measurement Checklist



*By the next month, the technician will see that the farmer has a compost:*

- ☐ Located in a good location (Shaded, access to water, near a potential prime application area (permagarden, orchard, etc))
- ☐ Correct dimensions (Add dimensions here)
- ☐ Made up of the correct materials
- ☐ Correctly layered in good proportions/ratios (4 part brown, 1 part green, additional white/grey as available (no more than 1 part))
- ☐ Actively managed (Watered, aerated/turned, correct temperature, materials being added to it)

## Flex Activity: Constructing and Using an A-Frame

### Description

This activity instructs farmers how to develop contours by using A-frames. Participants will discuss contour agroforestry lines and how to properly apply the technology to their Forest Gardens through the construction and use of an A-frame.

On hilly or mountainous landscapes, this module should be conducted early in the program (before or during the Outplanting workshop in Year 1) to establish the tree planted contour rows to minimize erosion. On flatter landscapes, where water erosion is not as serious of a concern, contour rows can be planted later in the program so that they can aid in water conservation. For these areas, the module can be conducted during the Optimization or Water management modules in Year 2, and contours may be limited to vegetative strips.

**Total Time:** 90 minutes

### Pre-Activity Checklist

- The facilitator should consult the technical manual to review the process of constructing and using an A-frame.
- Ensure that enough A-frames (3-5) will be constructed or brought to the training site so everyone can participate in practicing marking contour lines.
- Note that high wind may make it difficult to use the A-frame. Use an object or body to block the A-frame from the wind if necessary. Using a heavy enough pendulum will prevent interference from wind.
- Decide whether pendulums or levels (or both) will be used for the A-frame construction during the workshop and familiarize yourself with the details of construction and calibration of that specific kind of A-frame.

### Materials

- ☐ Materials required for one A-frame construction. Multiply as needed depending on how many A-frames will be constructed in the group.
  - ☐ Two 2-3 m boards/poles about 2-5 cm in diameter (wood, bamboo, hard plastic, etc.) to serve as legs
  - ☐ One 1-1.5 m board or pole of the same material to serve as the crossbar
  - ☐ One 1.5 m piece of twine and one oblong rock for the level pendulum if using this method

### OR

- ☐ One bubble or spirit level if available
- ☐ Hammer and nails, and/or two meters of string to bind the wood together and attach the level
- ☐ 2-3 additional, preconstructed A-frames

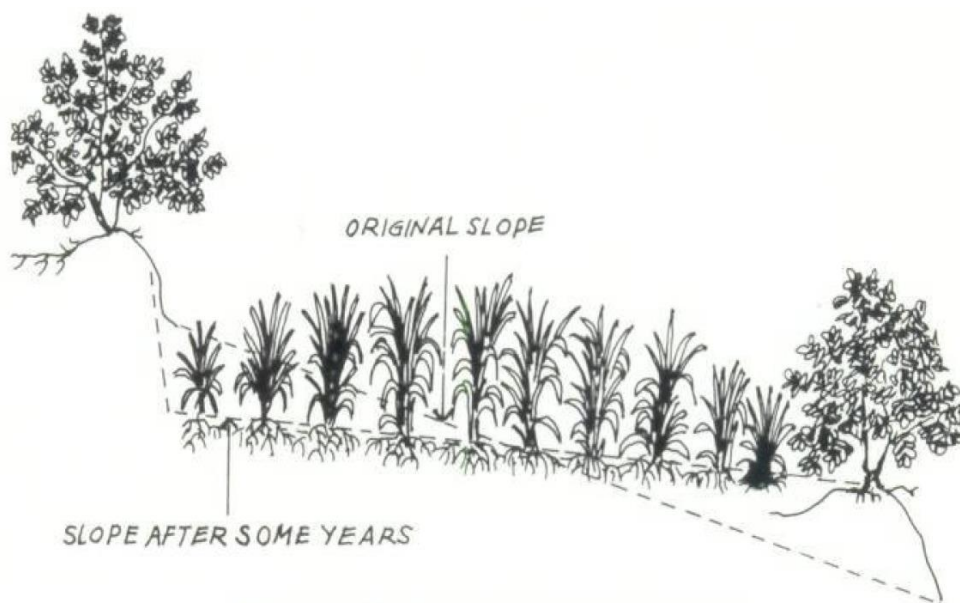
- ☐ Numerous sticks/other indicators to use as markers
- ☐ Spade and dig-axe/hoe for shaping contours

## Instructions

### 1. Introduce contour lines and their purpose

Lead the large group in a discussion about soil erosion and how planting along contour lines provides a solution.

- What is soil erosion and how does it affect soil?
- What are contour lines? How do they help prevent nutrient loss from soil erosion?
- How do contour lines help conserve water?
- What is a terrace?
- What is contour planting (see Figure 1)? How do roots of plants and trees affect the soil?
- Why does a contour line need to be at uniform elevation? What happens if it is not?
- Are you familiar with any tools that help find the contour?



**Figure 1: Contour planting on a hillside.**

### 2. Construct an A-frame

Using one of the pre-constructed A-frames, introduce it to the group and supervise the construction of 2-4 (based on size of group) using local materials.

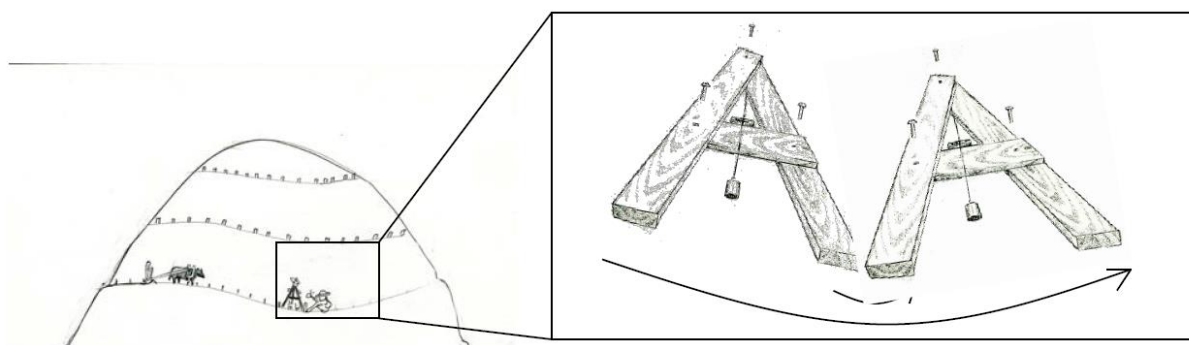
- How do we ensure we are planting at the same level across the hill?
- What is an A-frame? How does it help us identify where to plant contour lines?
- Why do the two long pieces of wood that serve as the legs have to be the same length?

- How do we attach the pieces together? How do we attach the string and tie it to the rock? (if using that method) How do attach the level to the crossbar? (if using that method)
- What purpose does the hanging rock serve? (if using that method)
- How and where do we calibrate the A-frame? How do we get as close to truly level as possible?
- Why do the legs need to be on nearly level ground to calibrate the rock pendulum model of an A-frame? Why do the legs need to be on perfectly level ground to calibrate the bubble level model of an A-frame?
- \*Note that by shortening the string to just below the crossbar, it might not swing as much, which will help.

### 3. Use an A-frame to find contour lines

Demonstrate how to use an A-frame to mark contours across the field, then divide the participants into small groups to work independently at other levels. Using the A-frame requires good teamwork. Volunteers in each small group take turns practicing how to find the level spot, turn the A-frame to advance it across the field, and mark the planting spots with sticks or other markers. The exercise should continue until all participants have used the A-frame successfully and the entire field has been marked (see Figure 2).

- How will we mark out the contour lines?
- How does the hanging rock tell us where to mark?
- Where should you start on the field when marking contours?
- How do you judge the distance between contour lines? Once you complete the first line across the field, how do you know where to start the next row?



**Figure 2: Using an A-frame**

### 4. Construct contours

Demonstrate to the large group how to shape the contours of the sloped field. Farmers then break into small groups of 4-5 people, practicing using the A-frames, shovels and hoes to dig swales and form berms along the contour lines marked in the previous activity.

- What is a berm and swale?
- How can shape the soil along contours by digging swales and forming berms?



- How do we decide whether to shape the land or just plant a row of trees?
- How many contour lines could we potentially place on this field?
- Can we use any rocks, sticks or other debris nearby?
- What are some potential problems in using rocks?
- How is this technology applicable in your own Forest Garden?
- Looking at this site and thinking about yours, how many contours might you plant?

### **5. Planting the contour**

After marking the contour lines across their fields, and forming berms along the contours, farmers will be ready to plant a variety of trees, shrubs, grasses and groundcovers across the contour rows. For steep locations, trees will be included in the design. For flat locations, the contours may be planted with grasses or other groundcover. Demonstrate the process of planting the contour lines in a small area while leading discussion, and then have farmers continue to plant all of the available planting material.

- What are some good plants and trees to use in contour planting?
- How close should we space trees along our contour row?
- Will the trees be outplanted or direct seeded?
- Which groundcovers under trees will minimize erosion?
- Which grasses can help fill out the contour row?
- What will the spacing be for plants and trees planted in the contour row?
- For contours that have been formed into berms, what can be planted on the inside or hillside of the berm? What can be planted on top? What can be planted on the outside of the berm?

# **END YEAR 1**



## Review, Optimization, and Planning

### Goal

Farmers will adopt optimization techniques that better utilize space, time, sunlight, and water to increase production efficiency by using top view mapping, side view mapping, and seasonal calendars.

### Part 1: Optimization

First, farmers will reflect on what they have learned throughout the Forest Garden program. Next, farmers will reexamine their seasonal calendars and top view maps to optimize and fill in gaps within their forest garden system. A new tool, the side view map, will assist farmers in maximizing vertical space in each layer of the Forest Garden. Finally, participants will identify new perennial crops to grow in their Forest Gardens and learn to design plant guilds to maximize efficiency.

### Part 2: Annual Planning

Farmers will identify their goals for the year for their Forest Garden. Taking the information from optimization, as well as their goals, they will develop their nursery, seed saving and crop rotation plans for the year.

### Learning Objectives

By the end of this module, farmers will be able to:

1. Review the progress of their learning and the development of their Forest Garden over the past year in the program.
2. Understand the concept of optimization and how to go through the optimization process on a regular basis in order to diversify crops, improve crop relationships, and improve time planting and harvesting.
3. Create a side view map and add in types of plants increase use of vertical space (e.g. timber trees, shrubs, and vines).
4. Update their Forest Garden Design based on identified gaps within the Forest Garden Design and areas of improvement on the Forest Garden design for the coming year.
5. Create an updated nursery plan, seed saving, and crop rotation plan for the coming year.

### Venue and Timing

This module should take place at the very beginning of Year 2, ideally before planting season, and should be located at the lead farmer or host farmer's farm.

### Relevant Technical Manual Chapters

- Chapter 1: Introduction to Forest Garden
- Chapter 2: Phased Approach



- Chapter 8: Agroforestry Technologies
- Chapter 13: Permagardening
- Chapter 15: Optimizing the Understory

## Preparation

- Inform farmers to bring their top-view maps, seasonal calendars, or any other Forest Garden Design materials.
- Print 2<sup>nd</sup> year MOUs
- Print a list of year 2 modules and timing or plan to write on flip chart

## New Concepts and Vocabulary

- Diversification
- Optimization
- Vertical space
- Side view mapping
- Perennials
- Annuals
- Goals (short-term, long-term)
- Crop rotation

## Supplies

- ☐ A small ball
- ☐ Flipcharts
- ☐ Markers
- ☐ 5 Copies of the lead/host farmer's top view map
- ☐ 5 Copies of the lead/host farmer's or group's seasonal calendar
- ☐ Vegetable picture cards
- ☐ Copies of Farmer MOUs to sign

## Total Time

4 hours

## Review and Optimization

### Summary of Activities

#### **PART 1: OPTIMIZATION**

**Opener:** Lessons learned ball toss (30 min)

- Congratulate farmers on completing the first year
- Farmers toss a ball and review what they learned in Year 1
- Review key points not discussed during the ball toss
- Introduce Concept of Optimization

**Activity 1:** Optimizing horizontal space (30 minutes)

- Field walk
- Create a top-view map to analyze horizontal space

**Activity 2:** Optimizing vertical space (45 minutes)

- Side view field walk
- Show example of side view map of a Forest garden visited during previous workshop
- Small groups create a side view map of the host farmer's Forest Garden
- Small groups present side maps and select best one
- Discuss gaps in the side view map

**Activity 3:** Optimizing time (30 min)

- Discuss the market price analysis calendar
- Update the market price analysis calendar
- Create seasonal harvest calendar
- Discuss gaps in the seasonal harvest calendar

**Activity 4:** Adding Perennial plants (30 min)

- Define perennials
- List perennials and how they might fill horizontal and vertical gaps
- Discuss propagation plans for them

#### **PART 2: COMING YEAR PLANNING**

**Activity 5:** Planning for the year (1 hour)

- Setting goals and Individual plans for the year
- Develop a crop rotation plan for the permagarden
- Develop a Tree Nursery Plan
- Develop a Seed Saving and Procurement plan
- Go over the year schedule

**Activity 6: Workshop Closure** (15 mins)



- Debrief on workshop topics
- Farmers evaluate workshop
- Assign take home activity

## PART 1: OPTIMIZATION

### Opener: Lessons Learned Ball Toss (30 min)

#### Description

Participants are given time to share what they learned during the first year of the Forest Garden Training Program to help farmers recollect techniques that have been introduced and prepare them for the optimization workshop.

#### Instructions

##### **1. Congratulate farmers on completing the first year**

Congratulate farmers on this milestone and remind them of where they are in the Forest Garden Training Program.

##### **2. Farmers toss a ball and review what they learned in Year 1**

Have the group stand in a circle. Start by stating something you learned in the past year and then toss the ball to a participant. The farmer then states something they have learned in the past year and tosses the ball to another participant that has not spoken. The game continues until everyone has stated something they have learned about Forest Gardens.

- What is a Forest Garden?
- What are the benefits of Forest Gardens compared to other cropping systems?
- What are Forest Garden layers? How do these layers help to maximize production?
- How do you protect and revitalize your field?
- How is soil fertility managed in a Forest Garden?
- What techniques have you learned and practiced? Any that have not been mentioned?
- What are you doing differently now than you were a year ago?

##### **3. Review key points not discussed during the ball toss**

Invite the group to ask any questions they may have about the training program thus far.

##### **4. Introduce workshop topic**

The facilitator familiarizes the group with Year 2 topics by reviewing the importance of diversification. Next, the facilitator helps the group define optimization and introduces the day's topic: reevaluating the Forest Garden Design and optimizing the Forest Garden to operate as efficiently as possible.



- What is meant by **diversification**?
- What are (at least) three ways diversification benefits farmers? (Soil fertility, pest management, family nutrition, resilient income, etc.)
- What is meant by **optimization**?
- Are our Forest Gardens perfect or are there opportunities to improve?

In this workshop we will discuss three ways to optimize the Forest Garden: Horizontal Space, Vertical Space, and Time. We will then take this information and your goals and objectives for this coming year and develop your nursery, crop rotation and seed saving plans.

## Activity 1: Optimizing Horizontal Space (30 min)

### Description

The group walks through the host farmer's Forest Garden before the host farmer presents their current top view map to the group. The facilitator guides the group in recreating the host farmer's map, updating it with any differences noticed in the field walk. Finally, the facilitator leads the group in identifying "gaps" in the top-view map for the farmer to fill.

### Instructions

#### 1. Field walk

Gather the group and have the host farmer lead them on a tour of the host Forest Garden. Ask farmers to take note of any landscape features, farming practices, crops, animals, buildings, etc.

- How many different Forest Garden technologies can you identify? Are there any opportunities to add more?
- Is there any space being underutilized?

#### 2. Create a top-view map to analyze horizontal space

Supervising the group with the host farmer, have them create a new top-view map of the host farmer's Forest Garden. After the map is completed, ask the group works to identify all the empty space and offers suggestions of what might fill that space in the future.

- Is our map very different from the original?
- Are all the trees and perennials mature? Will they occupy more space in the future?
- Is the space mostly empty or mostly full? Identify the empty spaces.
- What can be grown in these spaces? Are there any considerations that need to be accounted for? (Livestock friendly, drought resistant, traffic or commotion, security, crop rotation, etc.)

## Activity 2: Optimizing Vertical Space (45 min)

## Description

The group takes another field walk, only this time the facilitator draws attention to the vertical space. After the walk, farmers create side view maps of the host farmer's Forest Garden in order to analyze the use of vertical space.

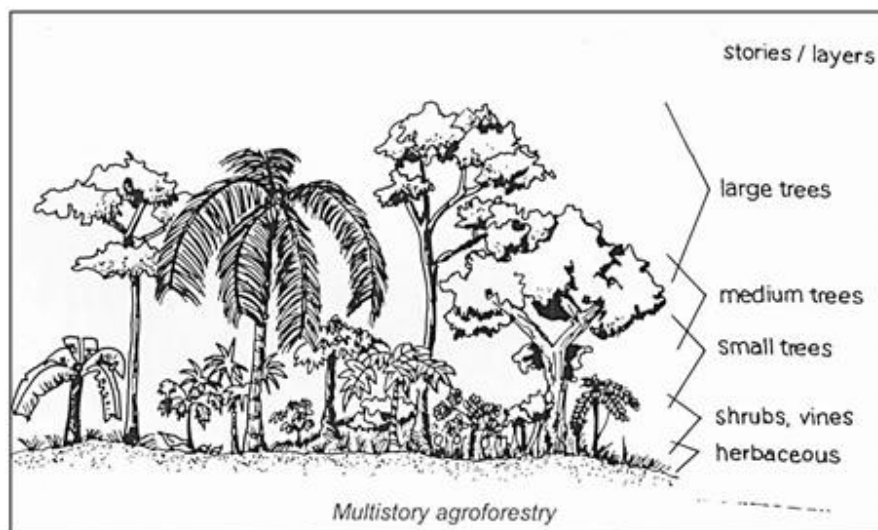
## Instructions

### 1. Side view field walk

Explain the concept of side-view mapping then leads the group in a second walk of the host farmers Forest Garden, this time focusing on **vertical space**. Instruct farmers to pay close attention to the Forest Garden layers and what plants occupy them.

- What are the different layers of plants in the Forest Garden?
- Are these layers all represented in the host farmers Forest Garden?
- Which layer is the most sparse? Which is the most dense?
- Why is sunlight such an important resource in vertical space? How can we plan to avoid competition for sunlight?

**Figure 1: Example of the different layers in a Forest Garden, from [www.worldagroforestry.org](http://www.worldagroforestry.org)**



### 2. Show example of side view map of a Forest Garden visited during a previous workshop

- How is this **side view map** different from other maps we have created?
- Is there space in the Forest Garden that is not being used?
- What types of plants could fill those gaps? (Timber, small shrubs, vines, etc)

### 3. Small groups create a side view map of the host farmer's Forest Garden



Groups of 4-5 farmers collect flip chart paper and markers to transect the host farmer's Forest Garden and draw a side view map.

#### **4. Small groups present side view maps and select the best one**

Each group presents their map and the whole group decides which is most accurate and why.

#### **5. Discuss gaps in the top view map and provide suggestions**

Lead the group in an analysis of the side view map. Using their knowledge about each Forest Garden layer, have farmers suggest locally relevant crops that might fill gaps in the vertical space.

- What are the top three gaps in the sideview map?
- What types of plants could fill those gaps? Is there a plant for each layer?
- What kind of maintenance will the layers need?
- Which tall trees are good for timber?

### **Activity 3: Optimizing Time (30 min)**

#### **Description**

The facilitator and lead farmer help the group review and analyze the year's crop prices and how they relate to the seasonal crop calendar created in Year 1. The group agrees on an adjusted/updated seasonal calendar after discussing improvements that can be made and expectations for next year. Finally, each farmer sets goals for improvement to meet in Year 2.

#### **Instructions**

##### **1. Discuss the market price comparison calendar**

Lead the group in reviewing their market price calendars from Forest Garden Planning in Year 1 and comparing them to the actual prices they received for their crops this year. Discuss with the group any differences that arise and note if anything is expected to be different for the coming year.

- Review the prices from the old seasonal calendar, crop by crop. Are they accurate? Were this year's prices different?
  - Did anything exceed expectations? Did anything disappoint expectations?
- Do we expect the same prices this year?
  - Did any events happen this year that changed the price of certain crops? Are these events likely to happen next year?
- Review the list of crops. Should any be added? Should any be removed? Why?
- How can you shift production or storage to meet some of the higher price seasons?
  - Shift your planting times.
  - Work on storage or value addition.



## **2. Update the market price comparison calendar**

After discussing the inaccuracies of the old seasonal calendar and what to expect for next year, the group creates an updated seasonal calendar.

(See Appendix A)

## **3. Create a new calendar to track what is harvested in the Forest Garden each month**

Create a new line under the seasonal calendar for products harvested. Ask farmers to list all of the products that they are able to harvest from the Forest Garden each month. These should be products that are ready to harvest, so if their fruit trees are not yet producing, they should not be included.

## **4. Discuss gaps in the seasonal harvest calendar**

The group examines their new seasonal calendar for strengths and weaknesses as the facilitator guides discussion.

- What time of year does the Forest Garden produce the most? The least?
- Think about all the layers of the Forest Garden and potential crops. Is there anything that can be added to the Forest Garden for food or income in the slow months?
- How can we extend production? Are there crop varieties that fruit late or early?

(See Appendix B)

# **Activity 4: Adding Perennials to the Forest Garden (30 min)**

## **Description**

After creating a list of locally relevant perennial plants, farmers add them to their Forest Garden designs to diversify the permagarden and optimize horizontal and vertical space.

## **Instructions**

### **1. Define perennials**

Introduce and discuss the concept of perennial crops and annual crops. Provide examples of useful perennials while explaining the benefits of planting perennials in the Forest Garden.

- What is meant by the terms “**perennial**” and “**annual**”?
  - Are fruit trees perennial or annual? Tomatoes? Ginger? Garlic? (perennial, annual, perennial, perennial)
- What are the benefits of planting perennials?
  - Labor - saves time spent clearing, tilling, planting, and repeating.
  - Money - saves income spent on labor, seeds, and other inputs.



- Efficiency - annual plants spent much of their lives in vegetative growth while perennials can save their energy for fruiting.
- Do perennials last forever? (Potentially, but many perennials must be periodically cut down and replanted to maintain health and vigor, especially if they are very old.)
- How might perennials help to optimize our Forest Garden?

## 2. List perennials

Have the group work together to identify all the locally relevant perennials they can think of and compile them into a central list on the flipchart. Even unfamiliar crops that farmers might wish to experiment with can be mentioned.

- All fruit trees are perennial. How many species do we already have in our Forest Gardens? Are there any we would like to add that are not currently there?
- Many herbs are perennials. How many can we name?
- Many tubers and underground crops are perennials. How many can we name?
- What are the most promising perennials for marketing?

## 3. Add perennials to the Forest Garden Design

Each farmer will think about the perennials just discussed and add at least one to their design in a good location for it.

- What part of the Forest Garden might be good to integrate more perennials into?
- Are there some perennials that we just listed that can tolerate shade and be planted in the understory of some of the shadier areas?
- Are there perennials you think would be very good in the Permagarden as borders or within beds?

# PART 2: YEAR 2 PLANNING

## Activity 5: Annual Planning (1 hour)

### Description

Farmers establish goals for the year and create individual plans for their Forest Gardens.

### Instructions

#### 1. Setting goals

Explain the importance of setting **goals**. Ask a few volunteers to share a few of their goals for their Forest Garden for the year. Working individually or discussing in small groups, each farmer develops 2-3 goals that they will achieve in the coming year, integrating some of the concepts from optimization. These goals can be written into the Farmer Workbook and will be added to for the take-home activity.

- What is a goal and why is it important for businesses (i.e. farms) to have them?



- Different types of goals can include production goals, pest reduction goals, soil improvement goals, new enterprises to add, more food for the family, a big purchase like a car, etc.
- What might be the difference between a short-term and a long-term goal? Why is the difference important for Forest Gardens?
- Why is it important for a goal to be realistic?
- What questions should we consider when setting out goals?
  - Do you need to replace any trees? How many? Which ones?
  - What new trees do you want to plant?
  - Do you want to learn to grow any new vegetables?
  - Do you need to adjust any earthworks?
  - Any other new elements you want to add this year?
  - What needs to be done to meet your goals?
- How can we help each other achieve our goals?

## 2. Develop the Nursery Plan for the Year

Based on the gaps that the farmer needs to fill, ways that they want to optimize, and goals they have for their Forest Garden, demonstrate developing a nursery plan for the host farmer's Forest Garden nursery production. Using a pre-prepared table, have the host farmer (or volunteer) fill it in a table to capture the trees to be planted in each area of the Forest Garden this year. This table is also in the Farmer Workbook and will be filled out by each person for the take-home activity.

- What trees do you need to plan to fill gaps? (in the alleys, in the green wall, woodlot or orchard)
- What trees might you add to optimize space? (for example: subcanopy additions)
- How many will you need for each of those things?
- Are there any other trees you are interested in adding this year?
- How will you produce them? What kind of nursery bed?
- Will any be direct seeded?

Species by Area of the forest Garden	Number Needed for planting	Type of nursery (small sack, large sack, bare root) OR Direct Seed	Seeding Date
Live Fence			
Alleys			
Other			



### 3. Develop the Seed Saving Plan for the year

In this section, farmers will begin to list and think about where they might source seed for the year.

Explain to farmers that in this year they will learn the skills of saving seed and will set up their own home nurseries for tree and vegetable seed. Share with the group what seeds TREES will be providing this year.

Demonstrate developing a seed saving plan with the host farmer based on the trees that the farmers want to plant in the nursery, the vegetables they want to produce, and what TREES will be providing. This table is also in the Farmer Workbook and will be out by each person for the take-home activity.

- If TREES is providing these (X, Y, Z) seeds, what other seeds are you interested in growing this year?
- Where will you get them?
- Will you collect and save them, or buy them?
- Where will you source perennials? Is there mother stock somewhere you can collect or buy?

TREES Type	Amount Needed	Buy or Collect (add where)	Season/Month
VEGETABLES	Amount Needed	Buy or Collect	Season/Month

### 4. Develop the Crop Rotation Plan for the year

Using an example permagarden bed from the host farmer, ask the farmer to think about what was planted here before this crop was planted and what will be planted here after this crop is harvested.

- What was planted here last cycle?
- Is it the same as what is growing now?

Break into small groups and based on the farmers information on what was planted in prior years, each group develop a 4-crop rotation plan for the plots. If there are multiple plots then



you can assign different plots to different groups. Have them refer to the Crop Families chart in the Farmer Workbook.

- To set up crop rotation, Think of a single plot in your Forest Garden...
  - What was growing there last cycle?
  - What is growing there now?
  - What will you plant there next year? (different family)
  - What will you plant the year after that? (different family)

After developing the plan, ask each small group to present their crop rotation plan to the large group. Remind the group that this rotation should be done for every plot/section of the forest garden for non-perennial plants.

The group discusses crop rotation as a primary tool in IPM, soil fertility, and plant health.

- What happens to pests when we plant the same thing in the same place multiple times in a row?
- What happens to the plants when we plant the same thing in the same place multiple times in a row? (less healthy, more susceptible to pests)
- How do crop families relate to pests?
- What crop family should be planted here next year?

	Bed 1	Bed 2	Bed 3
Season 1			
Season 2			
Season 3			
Season 4			

## 5. Go over the years schedule and Sign 2<sup>nd</sup> year MOUs

Write the year's schedule of workshops on a Flipchart and discuss with farmers when each workshop will happen and what will be covered in each workshop. Have farmers sign 2<sup>nd</sup> year MOUs.



## Activity 6: Workshop Closure (15 minutes)

### Description

The facilitator debriefs the workshop and checks for understanding. Farmers should be aware that Forest Gardens should always be evaluated and optimized in order to increase production, yields, and income.

### Instructions

#### 1. Debrief on workshop topics

The facilitator poses some brief questions to the group to check for understanding and address any questions farmers might have about optimization.

- What is diversification and why is it helpful?
- What is meant by optimization? Is optimization something you only do once?
- What tools did we update/create today?
  - Our seasonal calendars to optimize time.
  - Our top view maps to optimize horizontal space.
  - Our side view maps to optimize vertical space.
  - A list of perennials and some guild designs to help us maximize efficiency.
  - A list of goals and a work plan to help us achieve them.

#### 2. Farmers evaluate the workshop

- How would you rate today's workshop?
- What was the best/most important thing?
- Is there anything that is not clear?
- What could be improved?
- Any other suggestions?

#### 3. Assign take home activity

## Take-Home Activity: Optimization and Year Planning



## Description

Farmers will think about their major goals for the development of their Forest Gardens. Farmers will take the concepts of optimization through space and addition of specific crops and trees and will update their top view map and create a side view map. They will develop their year plans for nursery production, seed saving and crop rotation.

## Instructions

- 1. Farmers confirm and edit their year's goals for their Forest Garden**, writing at least 2-3 goals and share with their families.
- 2. Farmers update their Forest Garden Design** based on the concepts of optimization and their goals for the year.
- 3. Farmers create side view map**  
Using the techniques learned in today's workshop, farmers will create a side view map unique to their Forest Garden and develop a plan to maximize vertical space within it.
- 4. Farmers develop a nursery production plan**
- 5. Farmers develop their seed saving plan**
- 6. Farmers develop a crop rotation plan** for all of their beds that have blocks of vegetables (not necessary for groupings or guild plantings)

## Follow-up

The lead farmer or technician will visit participant farmers' Forest Gardens within 2 weeks to check on the top view and the side view maps, and verify farmers' plans to optimize their Forest Garden. They will also look at the nursery, seed saving and crop rotation plans, and help farmers complete them if they have not been able to.

## Performance Measurements

As a result of this training, it will be observed that the farmer has:

- ☐ List of 2-3 goals for their Forest Garden for the year
- ☐ Updated top view map of Forest Garden
- ☐ Created side view map of Forest Garden
- ☐ A plan for their nursery production
- ☐ A plan for seed sourcing for the years' seeds and perennials.
- ☐ A plan for crop rotation in their permagarden.

## Appendix A

### Calendar 1: Price Analysis (Activity 5)

Months	January	February	March	April	May	June	July	August	September	October	November	December
Product 1								😊	😊	😊	😊	😞
Product 2		😊	😊	😞	😞							😊
Product 3	😞	😞			😊	😊						😊
Product 4	😊	😊	😊	😊	😊	😊	😊	😊	😊	😊	😊	😊
Product 5				😊	😊	😊	😞	😞	😞			

## Appendix B:

Months	January	February	March	April	May	June	July	August	September	October	November	December
Products harvested		jujube	Mango jujube	jujube				Greens Beans	Cabbage ans Maize Pumpkin Papaya Pigeon pea	Papaya Pigeon pea	Papaya Pigeon pea	orange

## Pruning

### Goal

Farmers will learn to prune seedlings, fruit trees, line plantings and timber trees for form, health and productivity.

### Learning Objectives

By the end of this workshop, farmers will be able to:

1. Use pruning tools safely.
2. Properly sanitize and maintain clean tools to avoid transmission of diseases and pests.
3. Prune seedlings in the nursery according to their future purpose in the Forest Garden.
4. Prune the living fence to encourage formation of a hedge
5. Prune fast-growing trees in alleys or contours at the base of the tree for leaf biomass and wood.
6. Prune medium and large fruit and timber trees to improve their form and efficiency.

### Venue and Timing

The workshop will take place during the dry season in Year 2 or 3, when alley and contour trees are tall enough to be coppiced. It will take place at the lead farmer's farm or a designated training site where all the Forest Garden components are available for pruning, and where farmers can work with trees of different sizes (young, medium, old).

### Relevant Technical Manual Chapters

- Chapter 11: Pruning, Harvesting, and Tree Management
- Chapter 12: Cut and Carry Livestock Management

### New Concepts and Vocabulary

Facilitators should prepare these terms and concepts ahead of time so they know how to accurately describe these things in local and appropriate language, during the course of the activity.

- |              |                                 |
|--------------|---------------------------------|
| • Pruning    | • Dormancy                      |
| • Pollarding | • Pruning Shears/Secateurs      |
| • Coppicing  | • Green manure/green fertilizer |
| • Tree Crown | • Leader branch                 |



## Preparation

- Identify the trees that need pruning for health and form (fruit/timber), coppicing and pollarding (fast growing multipurpose trees). These trees may have been present in the field before the forest garden approach began implementation.
- Set up adequate first aid supplies on site in a central location.
- Inform farmers to bring their Forest Garden designs to the workshop
- Inform farmers to bring their machetes and cutting tools they may have
- Set up tool sanitation station in a central location easy to access between each activity

## Supplies

- ☐ Bleach for sanitizing tools
- ☐ Clean rag
- ☐ 2 rakes
- ☐ A sufficient number of the following pruning implements to ensure there are enough for practice in small groups (1-5 of each type implements):
  - ☐ pruning shears
  - ☐ hand shears
  - ☐ pruning saws
  - ☐ pruning knives
  - ☐ scissors
  - ☐ machetes (each farmer requested to bring their own)

## Total Time

~3 hours



## Pruning

### Summary of Activities

**Opener:** Tree Management Introduction (15 minutes)

- Why Prune?
- Sharp Tools, Cleanliness and Disease Management
- Pruning Basics on a Dead or Dying Branch

**Activity 1:** Pruning Fruit and Timber Trees in the Field (45 minutes)

- Pruning Fruit Trees for Health, Form, and Production
- Pruning Timber Trees for Health and Form
- Farmers Clean Pruning Implements

**Activity 2:** Pruning in the Nursery (30 minutes)

- Basic Techniques for Pruning in the Nursery
- Slow-growing trees, Fruit trees, and Multipurpose trees in the nursery
- Small Groups Practice Pruning in the Nursery

**Activity 3:** Pruning the Green Wall (30 minutes)

- Pruning Thorny Species in the Green Wall
- Pruning Windbreak Species in the Green Wall
- Farmers Clean Pruning Implements

**Activity 4:** Pruning Alleys and/or Contour Trees (30 minutes)

- Pruning Alleys and/or Contours
- Using the Leaves from Pruning for Green Manure
- Using Leaves from Pruning for Livestock Fodder
- Farmers Clean Pruning Implements

**Activity 5:** Forest Garden Design Paired Review and Workshop Closure (30 minutes)

- Farmers Partner to Review their Forest Garden Designs
- Debrief on Workshop Topics
- Participants Evaluate the Workshop



## Opener: Tree Management Introduction (15 min)

### Description

The group learns the importance of pruning while the facilitator demonstrates proper tool use and cutting techniques using an example tree with some dead or diseased branches. They discuss issues of cleanliness, sharp tools and clean cuts and finish by cleaning the tools.

### Instructions

#### 1. Why Prune?

Form a circle around the demonstration tree and open a discussion on the importance of maintaining trees to maximize their benefits and maintain their health. Invite farmers to share their own experiences with pruning or maintaining trees.

- What is pruning?
- What are the reasons we may want to cut the branches of a tree? (product, form, health)
- When have you cut tree branches in the past, and for what purpose? What techniques do you know or have used?
- Can you make the tree grow taller or bushier?
- Did you know pruning can make a tree live longer? Produce more fruit and timber? Produce more leaves and firewood? Did you know that pruning fruit trees when they are young can make them produce a lot more fruit than unpruned trees when they are older?
- Is this tree growing well? Why or why not?
- How might we prune this tree?

#### 2. Sharp Tools, Cleanliness, and Disease Management

Gather the group at the sanitizing station and lead the small groups in proper sanitizing and cleaning of their pruning tools, in order to avoid transferring diseases or pests from tree to tree. Discuss sharpening tools to maintain the effectiveness of the tools. The group looks at different tools and talks about their use for different cutting tasks.

- What are the different tools you may use for pruning or cutting branches?
- Why should you always clean your tools? (Avoid spread of disease and fungal pathogens.)
- When should you clean and sanitize your tools? (before work, between cuttings, at the end of work)
- How do you clean your tools?
- How does tool maintenance and maintaining sharp tools protect the health of the tree?

#### 3. Pruning Basics on a Dead or Dying Branch



Gather the group at a demonstration tree in the surrounding area with dead or diseased branches needing maintenance. Instruct the group to stand in a semicircle around the tree so that all can see and hear as you demonstrate proper tool usage and cutting techniques.

- How can you tell this branch is dead or dying?
- How do you properly cut a branch?
- How do you hold and use this tool with safety in mind, to prevent injuries?
- What angle (on the tree branch) should you use when cutting with a saw? Why?
- Where exactly should the cut be made in relation to the trunk?
- What is the importance of the folding bark around the base of the branch? How does it help heal the wound and form a callous?
- How can improper cuts increase risk of disease?
- Why is it important not to rip or tear branches or to remove any of the tissue around the base of the branch?
- What should you avoid doing when making a cut on a branch or trunk?

## Activity 1: Pruning Fruit and Timber Trees in the Field (45 minutes)

### Description

The facilitator demonstrates and the group discusses best practices for pruning fruit and timber trees for health, form and fruit production. Farmers practice pruning fruit trees in small groups.

### Instructions

#### 1. Pruning Fruit Trees for Health, Form, and Production

Move with the group to a mature fruit tree that needs pruning, using it for reference. Conduct a discussion on why pruning is important for maintaining healthy and productive fruit trees, then demonstrate the best practices for pruning fruit trees at each point in the tree's life, from outplanted seedling to mature tree. After demonstrating, have farmers practice pruning areas of the fruit tree.

- Where would we cut here?
- How would we cut?
- Why is pruning to make a tree more bushy important for fruit trees?
- Can you make a tree more productive? How does pruning help with fruit production?
- Why do we prune fruit tree seedlings in the nursery?
- How should we prune young, outplanted fruit trees?
- Why should we remove any branches lower than 1 meter?
- How does cutting different branches at different times affect the tree?
  - How is it good for tree health?



- How is it good for productivity?
- What is a leader branch? What makes it different from other branches and what considerations should they be given when pruning?
- What time of year should we prune young fruit trees?
- How should we prune mature fruit trees?
- How can you tell if a tree has a diseased or damaged branch?
- When should we prune mature fruit trees?
- Is it possible to over prune a fruit tree?

## **2. Pruning Timber Trees for Health and Form**

After finishing work with the fruit trees, move the group to a mature timber tree.

- How old should they be when they are first pruned?
- How often should timber trees be pruned?
- How should we prune timber trees?

## **3. Farmers Clean Pruning Implements**

As in the opening activity, lead the group in cleaning their implements while stressing again the importance of sanitation.

# **Activity 2: Pruning in the Nursery (30 minutes)**

## **Description**

Farmers practice best practices for pruning after the initial phase of growth in the nursery. Farmers will learn how fruit trees and multipurpose trees are pruned differently in the nursery depending on their desired characteristics.

## **Instructions**

### **1. Basic Techniques for Pruning in the Nursery**

Demonstrate the technical aspects of pruning in the nursery using shears/clippers and discuss best practices.

- What are the best tools to use when plants are young? (Small garden shears)
- When should you prune trees in the nursery?
- What is one risk of pruning too early? Too late?
- How are different types of trees pruned in different ways?

### **2. Slow-growing Trees, Fruit Trees and Multipurpose Trees in the Nursery**

Discuss with the group some considerations when deciding how to prune different trees in the nursery.

- How should we prune fruit tree seedlings? Why?
- Why is it important to shape the fruit tree early on?



- How and when do we prune thorny trees in the nursery? How often?
- How should we prune fast-growing multipurpose tree seedlings?
- How should we prune timber trees in the nursery?
- How often should slow growing trees be pruned if they will stay in the nursery for a long time?

### **3. Small Groups Practice Pruning in the Nursery**

Divide the group into small groups to practice pruning in the nursery. Groups should rotate to enable farmers to practice on both fruit trees and multipurpose trees. The facilitator should closely supervise the work to ensure no seedlings are damaged.

## **Activity 3: Pruning the Green Wall (30 minutes)**

### **Description**

The facilitator leads the farmers on a review and practice of pruning thorny and non-thorny species in the Green Wall, introducing the practice of weaving branches together to reinforce the wall.

#### **1. Pruning Thorny Species in the Green Wall**

Review pruning thorny species in the Green Wall with the group and have volunteers demonstrate before small groups practice. Then demonstrate the practice of weaving pruned thorny branches back into the green wall for reinforcement.

- Why do we prune the Green Wall?
- How/how often should we prune the green wall?
- What kind of pruning do we do for thorny species?
- Where should we cut the trees?
- What tools should we use?
- At what height should thorny trees be cut?
- How should you weave the pruned branches back into the fence?

#### **2. Pruning Windbreak Species in the Green Wall**

Demonstrate practices of pruning non-thorny windbreak species in the Green Wall and have small groups practice.

- What is the purpose of non-thorny species in the Green Wall?
- How should we prune the non-thorny species?
- What is the danger of removing too many branches from the windbreak? Why do we want to keep about 80% of the wall in place?
- How much can we remove? (recommended to only remove single branches rather than coppicing or pollarding, to maintain wind break function)
- How do we prune non-thorny species in the Green Wall?



- Where should we cut?
- How often should we cut?

### 3. Farmers Clean Pruning Implements

Direct the group to the cleaning station to clean their implements.

## Activity 4: Pruning Alleys and/or Contour Trees (30 minutes)

### Description

The facilitator leads the group in discussing and demonstrating pruning, coppicing and pollarding techniques for multipurpose forest trees in alleys and/or contours and where they might be appropriate. After the demonstration, small groups will practice. The group then discusses use of the leaves for green manure and livestock feed. *Note: not all regions will have contours.*

### Instructions

#### 1. Pruning Alleys and/or Contours

Move with the group to the alleys and/or contours and demonstrate while explaining the two main techniques (coppicing--cutting at the base and pollarding--cutting at head height) for pruning trees in alleys and/or contours. Have farmers practice each type in small groups.

- What happens if you do not prune your alley trees?
- What are the different ways you might prune fast growing alley trees? (1. coppicing--cutting at the base; 2. pollarding--cutting at head height; 3. pruning individual branches for health or sunlight)
- Why/when would you do each of these techniques?
- Which species might be best suited for these different management techniques?
- How far above the ground should you cut (for coppicing)?
- At what age and what time of year should you prune your alley cropping and contour trees if you are harvesting all branches for green manure?
- When can you prune these trees if you are cutting some branches for feeding livestock?
- How often can you cut the regrowth (for coppicing/pollarding or individual branches)?
- Should you cut all regrowth at once or leave some poles? Why/when might you want to prune individual branches and why might you cut all branches?
- What are some challenges or things to watch out for with coppicing, pollarding and pruning individual branches? Can pruning risk longevity of the tree?
- Why might you want to prune trees around the Permagarden?
- What time of year should we prune multipurpose forest trees? (Refer to dormancy)



- What are the risks of pruning at other times? What are the risks of pruning too frequently?

## **2. Using the Leaves from Pruning for Green Manure**

Once small groups have finished practicing pollarding and coppicing and pruning individual branches, gather the large group together and demonstrate the use of leaves from branches for green manure. Following this, the group practices spreading the branches on the ground for green manure application.

- When you prune, what can you do with the branches and leaves?
- How does this pruning practice relate to soil fertility? (green manure)
- What do we mean by **green fertilizer** or **green manure**?
- How do leaves improve the soil? What are they giving to it? (They provide organic matter and an ability to store water like a sponge. They provide major nutrients found in NPK fertilizer as well as micronutrients that are not).
- When you prune for green fertilizer, what should you do with the branches? Where should you drop them on the ground. (Spread leaves and branchlets evenly across the ground in the alleys as a ground cover, and then rake or mix the leaves lightly into the topsoil so that all organic matter is captured.)
- When can you collect the wood from the pruned branches, and what can you do with it? (After a few days, once all the leaves have fallen off)
- Is it necessary to incorporate the leaves into the soil through plowing or raking? Why?
- Where else can we use the leaves? (Anywhere there is low soil fertility in the Forest Garden, using the same process of bringing the pruned branches and spreading them on the ground evenly; Farmers can also use the leaves as mulch for cuvettes or add them as green material to the compost.)

## **3. Using Leaves from Pruning for Livestock Fodder**

Discuss with the group the practice of using these same pruning techniques to sustainably harvest fodder or livestock.

- Are there any dangers of feeding these tree leaves to animals? (Leucaena especially)
- Which animals can be fed these leaves and which cannot?
- What percentage of this can we feed to those animals?
- How might you mix a feed ration?
- What is the best way to conserve leaves for fodder use later?
- Are there options for transformation of leaves?
- Where is the best place to store leaves for fodder and in what containers?

## **4. Farmers Clean Pruning Implements**

Direct the group to the cleaning station to clean their implements.



## Activity 5: Paired Forest Garden Design Review and Workshop Closure (30 minutes)

### Description

Farmers pair up with another farmer who knows their field. They review their Forest Garden designs together and share which trees will be pruned, where they are on the design, and what kind of pruning they will do for each type/area. They also share what they will do with the cut branches and leaves. The facilitator summarizes the lessons learned throughout the workshop and checks for understanding among the participants.

### Instructions

#### **1. Farmers Partner to Review their Forest Garden Designs (15 minutes)**

Guide farmers to pair up to review their Forest Garden designs together and share how they will be implementing the practices learned in the workshop on their own field. Ask them to show each other where the trees are in their design that they will begin pruning and to discuss what steps they will take.

- Which trees will you prune in your field? Why?
- How will you prune them? Where on the tree?
- What will you do with the resulting branches and leaves? Green Manure, livestock, fuel?
- What parts of your Forest Garden need the most improvement?
- Is soil fertility good throughout?
- Is water runoff a problem.
- How might pruned branches be used to improve these specific areas?

#### **2. Debrief on Workshop Topics (5 minutes)**

Pose questions to the group to check for understanding of the workshop topics. Any topics that are unclear or concerns that the group may have should be addressed by the facilitator.

- Why is pruning important?
- How might pruning be different for fruit trees and multipurpose forest trees?
- What different ways can you prune trees?
- How does what was learned today relate to water conservation, soil fertility or IPM?
- How do you plan to use what you have learned today to manage trees in your Forest Garden?
- What questions do you have? Is there anything that is not clear?

#### **3. Participants Evaluate the Workshop (5 minutes)**

Briefly ask participants these questions to evaluate the success of the workshop and identify areas for improvement.

- What was the most important thing you learned?



- What could be improved? Any suggestions?

## Take Home Activity: Pruning Your Forest Garden Trees

### Description

Farmers use their knowledge of pruning in their own Forest Gardens.

### Instructions

#### 1. Continue to prune the Green Wall

Farmers continue to prune thorny trees in the Green Wall for lateral branching and to maintain a height of 1.5 m. All Green Wall trees show evidence of pruning. Green Wall thorny trees show evidence of lateral branching. Pruned branches are woven back into the live fence.

#### 2. Continue to prune trees in the nursery

Farmers continue to prune in the nursery. Fruit and Timber nursery seedlings show evidence of pruning for health and form, being tall with no lower branching. Green wall seedlings show evidence of pruning for lateral growth.

#### 3. Prune fruit trees

Farmers will use their knowledge of pruning to prune the fruit trees in their forest gardens when they are in need, for health and form.

- Be careful not to over prune.
- Remove dead, damaged, and diseased branches;
- Decrease the density of the branches to promote air circulation, healthier growth, and productivity.

#### 4. Prune timber trees

If farmers have timber trees in their plot, they prune them for form, encouraging straight trunks and few lower branches.

#### 5. Coppice and/or Pollard multipurpose forest trees in Alleys and Contours

Farmers coppice their multipurpose forest trees in alleys to encourage rapid growth.

- Trees are pruned at the appropriate time.
- Trees are pruned correctly with clean cuts at the right height.
- Resulting leaves and branches are being used (green manure, fodder, fuelwood).

### Follow-up



The lead farmer will visit participants in 2-3 weeks to ensure that each farmer has completed these activities in their field.

## Pruning Performance Measurements Checklist

As a result of this training, it will be observed that the farmer has:

- ☐ Pruned any unhealthy branches in the Forest Garden. No Trees in the nursery show major damaged or diseased limbs.
- ☐ Continued pruning thorny trees in their Green Wall to form a hedge, with terminal bud pruning and lateral branching.
- ☐ Woven long pruned thorny branches back into the Green Wall to reinforce it.
- ☐ Pruned non-thorny branches in the Green Wall appropriately (not too much pruning)
- ☐ Continued to prune thorny trees in the nursery for lateral branching.
- ☐ Pruned slow growing trees in the nursery for form and health.
- ☐ Pruned young fruit trees for better form removing low branching.
- ☐ Pruned timber trees for better form removing low branching.
- ☐ Correctly coppiced their alleys/contours cutting at the right height (15-45 cm above ground) with clean cuts and little signs of breakage or tearing.
- ☐ Correctly applied resulting green manure to the field by spreading evenly and incorporating in alleys (or other targeted areas).



## Integrated Pest Management

### Goal

Farmers will build pest resilience in their Forest Gardens by adding more natural solutions and techniques to the preventive measures learned in year one. Farmers will learn to identify pests, create and apply natural remedies, and maintain good sanitation and healthy plants.

### Learning Objectives

By the end of the workshop, farmers will be able to:

1. Describe IPM and how natural pesticides are different from chemical pesticides.
2. Scout their fields and use observation and discussion to identify ways to address problems.
3. Identify pests and their corresponding natural treatments with assistance of an IPM Tool.
4. Make three natural pesticides applicable to pests identified in the zone.
5. Set traps for insects or other pests, if relevant regionally.
6. Keep their Forest Garden and tools sanitized and clean of debris to prevent pest and disease infestations.

### Venue and Timing

The workshop should take place at the beginning of the rainy season gardening period, when there are a few pests in the field to practice identifying, but early enough that farmers can use the skills to prevent fields from being overrun by too many pests.

### Relevant Technical Manual Chapters

- Chapter 16: Integrated Pest Management

### New Concepts and Vocabulary

Facilitators should prepare these terms and concepts ahead of time so they know how to accurately describe these things in local and appropriate language, during the course of the activity. Local language should always be used rather than using English or French technical terms.

- Integrated Pest Management (IPM)
- Scouting
- Chemical/pesticide resistance
- Beneficial insects (pollinators and predators)

### Preparation



- In consultation with the lead farmer, identify various pests that are common in the area and review IPM techniques that are suitable for their management, including 3 natural pesticides and 1 trap if regionally relevant.
- Prepare copies of the IPM Tool to use during the workshop.
- Identify and harvest crop samples that have been affected by pests (pictures when necessary).
- Capture a few example pests to have on hand for demonstration
- Gather the ingredients for the 3 natural pesticides that will be prepared during the workshop. These recipes should target different plants or different pests (e.g. one for foliage and one for tubers)
- Make 2-3 natural pesticide solutions ahead of the workshop to demonstrate application to the group. These should be the same 2-3 of the 3 that the group will make in the workshop.
- Have the host farmer set up a sanitation station. Farmers should wash hands and clean shoes after handling diseased plants.

## Supplies

- ☐ IPM pocket ring tool
- ☐ Pest identification poster
- ☐ Flipchart and Markers
- ☐ Specimens of common pests found in the area
- ☐ Containers to keep pests in during workshop
- ☐ Crop specimens that show pest damage
- ☐ Raw Materials needed for the creation of three natural pesticides
- ☐ Knives, pestle and mortar and other tools needed to process the ingredients for the natural pesticides
- ☐ Pest trap (materials to create or pre-made)
- ☐ 2 natural pesticide solutions that are already prepared by the facilitator
- ☐ Supplies for sanitizing tools, washing hands
- ☐ Water, cans, barrel, backpack sprayer, hand pump, and other items required to apply solutions

## Total Time

3.25 hours



## Integrated Pest Management

### Summary of Activities

**Opener:** What is Integrated Pest Management? (15 minutes)

- Recall IPM techniques we already know

**Activity 1:** Scouting, Identification, & Analysis (1 hour 30 minutes)

- Scouting and observation in the field
- Discuss the observations
- Identifying pests in large and small groups
- Deciding on solutions

**Activity 2:** Making Natural IPM Solutions (45 minutes)

- Natural vs. chemical pesticides
- Small groups create multiple natural pesticide remedies

**Activity 3:** Applying Natural IPM Solutions (45 minutes)

- Small groups rotate through stations to apply IPM solutions

**Activity 4:** Forest Garden Review and Workshop Closure (20 minutes)

- Review the basics of IPM
- Farmer workshop evaluation/feedback
- Assign the Take-Home Activity and Paired Forest Garden Design



## Opener: What is Integrated Pest Management? (10 min)

### Description

Review the many IPM techniques farmers have already learned. Then come up with a common definition of IPM with the farmers and describe 3 steps of observing, analyzing, and deciding.

### Recall

#### **IPM techniques we already know.**

Gather the group together and open a brief discussion on what IPM is, reviewing what farmers learned so far in the program.

- What are some of the Forest Garden Techniques and solutions for pest prevention that we have already learned? (Living Fences, Segmenting with Alleys, Composting, Companion Planting, Using neem leaves in the nursery).
- How do each of these things help prevent pests?
- Can anyone summarize and define for us what IPM is?
- How are natural pesticides different from chemical pesticides?
- Which is better for the soil, natural or chemical pesticides?
- What are “organic” crops? Why might they be preferable?
- Do natural or chemical pesticides harm beneficial insects and other organisms?
- Are natural pesticides completely safe with no risks?

In this workshop, we will learn more natural solutions to use in managing pests. The first step of IPM begins with observation, then analysis of what you have observed, then deciding on the best solution.

## Activity 1: Scouting, Identification & Analysis (1.5 hours)

### Description

Participants go through the process of observation (scouting), identification, and analysis to decide on best solutions for what they see. Farmers are provided with bags/containers as they arrive and are instructed to collect pests and signs of pests and disease in the field. The facilitator explains the use of the IPM Tool, and together the large group identifies a few of the collected pests and signs of pests and disease using the tool. Small groups then practice working with the IPM tool to identify the other pests that they have collected. The large group discusses potential solutions for each pest and disease using the tool and experience.

### Instructions

#### **1. Scouting and Observation in the Field (20 minutes)**



Divide farmers into small groups of three or five, and provide groups with plastic bags or containers.

- What is a pest? An insect? A weed? A fungus? A disease?
- What is Scouting?
- How do you do it?
- Should you scout in only one area of the farm?
- Can you find evidence of pest damage? The pest itself? Both?
- Where should you look? (On the underside of leaves, around crop residue, on fruit)
- Should you look on the ground?
- What should you look for? (insects in different stages, note how many/prevalence)
- When you are handling diseases and pests, what should you do to prevent further contamination in your field or another site?
- How do you prevent contamination in the field each time you visit?

Instruct the groups to go into the field and collect anything they consider to be a pest or disease or evidence of a pest or disease. Before going to the field, farmers should sanitize shoes and hands at the sanitation station. Farmers should collect samples for 5-15 minutes, until they have 3 examples. Ask groups to pay attention to how many pests or diseases of each type are present where they take the sample.

## **2. Regather from the Field Observations (5 min)**

Gather the group together to debrief their observations from the field. Farmers should wash hands after handling any diseased plants. Bring all the samples to a central area so that the group can discuss each.

- What part of the IPM process did we just do? (Scouting/searching/looking for pests.)
- How often should this be done?
- What are your general observations about pest and disease in this farm?

## **3. Identifying Pests in Large and Small Groups (30 min)**

“Now we will look at the pests and disease you collected and identify what you have.”

Introduce the IPM Tool to the group, explaining how it can help identify pests and solutions, and demonstrate how to use it with two pest examples (applicable for poster or booklet version).

- Why is it important to properly identify the pest?
- How is this tool organized?
- What information does the tool show us? (crop damage, pest life cycle stages, crops it affects, potential solutions)
- Do pests look the same their entire life?
- How would you use this tool if you wanted to identify this pest?



Give each small group a tool, and instruct each group to practice identifying their pests with the IPM tool with minimal assistance using the following prompt questions.

- How should we identify the pest?
  - What does the insect look like? (size, color, markings, etc.)
  - What stage is it in?
  - What is its behavior? (hopping, crawling, flying, boring, chewing, piercing and sucking, etc.)
  - What damage is it associated with? (discolorations, wilt, spots, holes, etc.)
  - What plant does it attack and where? (maize stalks, citrus fruit, lettuce leaves, etc.)
  - How can you know the difference between disease and pest damage? What is the connection between disease and pests?
  - What are beneficial insects? Are there also beneficial insects in the field?
- What are the signs of plant disease?
  - How do we know we are dealing with disease and not another pest?
  - What part of the plant does the disease affect?
  - What diseases do you see most frequently? On which crops?

#### **4. Analyze Other Field Issues**

After identifying as many pests as possible, invite small groups to share their findings in the large group. Discuss together the connection between pests and other things (soil fertility, water) pulling in other observations from the field. Write any suggested solutions connected to these observations on the flipchart.

- Are there many pests? How severe are the insect pests?
- Was there a lot of disease? Are diseases spreading?
- Which plants are being attacked?
- Is there enough water and moisture in the field?
- Is too much water causing disease or attracting pests?
- Do plants need water or fertilizer?
- Was the field sanitation clean?
- Did the field have vegetative borders that help prevent pest and disease spread?
- Are techniques being used to keep plants healthy?
- What other problems (weeds, weather conditions, nutritional deficiencies) did you observe in the field?
- How are pests like insects and diseases linked? How can controlling pests help control disease?
- When are plants most at risk for disease? (Under pest attack, poor nutrition, adverse water conditions, wounded, etc.) How can we prevent disease thinking about these things?

#### **5. Decide on Solutions (20 minutes)**



Lead the group in a decision-making process about what solutions could be used based on the pests they identified, solutions offered in the IPM tool, and additional broad actions based on what they observed in the field. Refer to any ideas of solutions written on the flipchart in the previous activity.

- Which management practices are needed in the field?
- Which natural solutions can we identify that can help address each of these pest challenges? Go through each pest you identified.
- Where do you find potential solutions in the IPM Tool?
- What is an “acceptable pest level”? Do natural pesticides kill all the pests? (No, they may reduce numbers, but often do not kill everything)
- Should chemical pesticides ever be used?

## Activity 2: Making Natural Pest Solutions (45 minutes)

### Description

The group reviews how natural pesticides are different from chemical pesticides. In small groups, farmer’s work to create 3-4 different natural pesticides. Then they go to the field and rotate through stations to apply the 3-4 IPM solutions of: natural pesticides, use of traps (for rodents or insects), and the importance of field and tool sanitation for preventing pest and disease infestation.

### Instructions

#### 1. Small groups create multiple natural pesticide remedies

Provided with materials and supervised by the facilitator, small groups prepare three or more natural pesticides and remedies. This can be done at stations that groups rotate through or each group can be assigned a different recipe, depending on the complexity of the remedies.

- Where can you find this recipe in the IPM Tool?
- What insect is this remedy used for? On what crop would you apply it?
- What raw materials are used to create this recipe?
- How are the raw materials prepared?
- How much of each ingredient do you use?
- How do you mix it together?
- How long does it have to sit?
- What kind of container should you keep it in?
- How long can you store it before using?

#### 2. Optional: Small groups make traps



If using a trap that needs to be constructed or assembled, include a station for constructing them asking the following questions:

- What materials do you use to make this trap?
- How do you put it together?
- What is it for?

## Activity 3: Applying Natural Pest Solutions (45 minutes)

### Description

Small groups move to the garden and practice applying each solution at a minimum of three different stations, as technicians support continued discussion. If more than one pesticide is being applied, then additional stations can be created.

***Station 1: Applying 2-3 natural pesticides (from the pesticides created ahead of time by the facilitator which should be the same recipes that were created by the farmers in Activity 2)***

- What insect is this remedy used for? On what crop would you apply it?
- What tools - such as brushes, branches, hand pump sprayers or backpack sprayers - are required to apply this natural pesticide?
- How must it be processed so that it can be applied properly? Should it be filtered?
- Does the natural pesticide need to be diluted with water?
- How often does it need to be applied? What about the rain?
- Where do you apply it on the plant? (leaves, fruit, soil around the plant)
- Is applying this natural pesticide enough to manage pests? (No! use in conjunction with other techniques.)

### ***Station 2: Field Sanitation and Disease***

Using an example diseased plant, areas of field debris, and farmer tools and sanitation supplies, lead small groups through the practices of managing diseased plants through plant removal, field and tool sanitation, understanding the link between pests, disease and sanitation.

- Why is it important to identify disease early?
- How are diseases spread in the Forest Garden? (Insects, moisture, contaminated water and soil, contaminated tools, other infected crops, wind, etc.)
- What measures can be taken to prevent or control disease?
- What are the remedies you can use when you find a diseased plant? What is the solution?
- What is the risk of leaving the diseased plant in the field? Why is it important to dispose of infected crop material?
- What is the best way to dispose of this plant?
- Should we put infected crop material in the compost?



- Should only diseased plant material be cleaned from the Forest Garden? (Also other dead material or debris that might attract pests).
- Which tools should be regularly cleaned or cleaned between uses? (Any farm implements that come into contact with plants, soil, or water)
- When are plants most at risk for disease? (Under pest attack, poor nutrition, adverse water conditions, wounded etc.)
- How can you make sure plants are more resistant to pests and disease (health, nutrition, compost)?

### ***(Optional) Station 3: Setting up Traps***

Some regions have success in using traps for pests, either for scouting aids to alert farmers to the first arrival, or to trap pests and prevent their damage. For regions that do, explain the use of traps, in the set of solutions for a station.

- What is this trap?
- How is it used?
- What insect pest does it work with?
- Where should you place it in the field?
- How often should you check it?
- If you notice pests in/on it, what should you do next?
- Where can the tool be purchased? OR how do you make it?

## **Activity 4: Forest Garden Review and Workshop Closure (20 minutes)**

### **Description**

The group pairs up discuss plans for implementing new IPM strategies on their own farms. The facilitator reviews the workshops topic and assigns the take-home activity.

### **Instructions**

#### **1. Review the basics of IPM (5 minutes)**

Gather the group and take 5 minutes to pose questions to the group to check for understanding and clarify any information that might be unclear to participants.

- What is IPM? Why is it preferable to chemical pesticide use?
- How are natural pesticides different from chemical pesticides?
- What is the first step to IPM? (Scouting)
- Why is it easier to prevent pests than control them?
- What are some of the many preventative techniques we reviewed today?
- Why is maintaining plant health so important to IPM?
- How are pests connected to disease? How do we deal with diseased plants?



- How does plant health affect its resistance to pests and disease? So how does compost relate to pests and disease?
- How do companion plants help manage pests?
- Which plants help repel pests? How can we attract beneficial pests?
- Why is crop rotation so important to IPM?
- What is one question you still have about IPM? Is there anything that is not clear?

Remind the group that IPM is never complete: farmers should always be scouting and planning and searching for new remedies and combinations of remedies that better manage pests on the farm, learning from past experiments to refine their solutions.

- What should be done if a remedy is not working at all? (Find out what's wrong, try a new remedy, or consult fellow farmers or experts.)
- What should be done if a remedy is working well? (Find out why it is so successful and see if it can be expanded to protect other crops. Share your knowledge with surrounding farmers.)
- How can other farmers help to improve your own IPM activities? (Consider meeting regularly and touring group members' farms to identify and pests and discuss remedies.)

## **2. Farmer workshop evaluation (3 min)**

Briefly ask participants these questions to evaluate the success of the workshop and identify areas for improvement.

- What was the best/most important thing you learned today?
- What is one thing that could be improved about the workshop? Any other suggestions?

## **3. Assign the take home activity and Paired Forest Garden design (10 minutes)**

Explain the take home activity. After assigning the take home activity, farmers pair up and review their Forest Garden designs, discussing their IPM plan in their permagarden. They discuss these questions and share the answers with each other. Before leaving the site to return home, farmers should sanitize shoes and hands at the sanitation station.

- What is the first step you will take in pest management with your Forest Garden when you go home?
- Are all the basic design preventative measures already in place in your Forest Garden? (intercropping, vegetative barriers, crop rotation, healthy soil/plants)
- How many compost piles do you have? Which plants will you apply compost to in order to help prevent pests?
- What pest recipe will you create first? Where will you apply it?
- Are there any other IPM strategies you will use from this workshop?

## **Take Home Activity: IPM solution implementation**



## Description

Farmers will independently implement some of the new IPM strategies in their Forest Gardens using the techniques they have explored in this workshop.

## Instructions

- 1. Begin scouting on a regular basis, practicing using the IPM Tool.**
  - a. Write down (or tell your technician) the top 3 common pests you are seeing in your garden and what they are eating.
  - b. Research potential solutions by talking to neighbors/friends, technician, using the IPM tool.
- 2. Make and apply at least 1 new pesticide recipe for pests you identify.**
- 3. Clean your garden of diseased plants and debris.**
- 4. Add a pest trap (if regionally applicable).**

## Follow-up

The lead farmer or technician will visit participants in 2-3 weeks to check on the implementation of skills from this workshop using the checklist below, offer advice, and see what resources the farmer might need to further practice IPM solutions. The technicians should record the IPM techniques being used by farmers to establish a list of best practices in the region.

## IPM Performance Measurement Checklist

As a result of this training, it will be observed that the farmer has:

- ☐ Scouted the field to be aware of insect presence, and can share what they have been seeing, including location, what plants are affected, prevalence of any type of pest or disease. For farmers who write, this should be recorded in their Farmer Workbook.
- ☐ Created and applied at least one new natural pesticide according to what pests are identified in the field
- ☐ Cleaned the field of debris. Anything diseased or might spread disease is removed.
- ☐ Applied a trap (if regionally appropriate)

## Seed Saving

### Goal

Farmers will learn to reduce input costs and increase seed availability by practicing proper seed saving techniques and establishing their own seed banks of tree and vegetable seeds. They will begin to save all possible open-pollinated seeds that they will need in their permagardens and tree nursery production, ensuring good nutrition, self-sufficiency, and cost savings.

### Learning Objectives

By the end of this workshop, farmers will be able to:

1. Explain the nutritional, economic and other benefits of saving seeds.
2. Successfully identify and mark source plants for 5-6 vegetables.
3. Properly collect, extract, process and store tree seeds.
4. Set up a personal seed bank following seed bank best practices concerning location, containers, and labeling.
5. Perform a germination test.
6. Optional: organize a group seed bank.

### Venue and Timing

The major activities in this module may be facilitated at one time, or split into two, according to the best season for tree seed collection and vegetable seed source identification. If trees in the zone have a distinct season when they seed, this workshop should occur in the beginning of the season so farmers do not miss any species. For vegetables, assuming most farmers will be looking for early fruiting plants that are hardy and have desirable fruit, this workshop can be timed either as the first plants begin to show fruit or as the fruit starts to ripen.

### Relevant Technical Manual Chapters

- Chapter 4: Seeds
- Chapter 5: Seedling Propagation
- Chapter 6: Fruit Trees (Rearing Fruit Seedlings section)
- Chapter 9: Popular Agroforestry Tree Species

### New Concepts and Vocabulary

Facilitators should prepare these terms and concepts ahead of time so they know how to accurately describe these things in local and appropriate language, during the course of the activity.

- |                   |                    |
|-------------------|--------------------|
| • Hybrid seed/GMO | • Germination rate |
| • Seed bank       | • Germination Te   |
| • Desiccant       |                    |
| • Viability       |                    |



## Preparation

*In advance of the workshop:*

- Review Technical Manual material on seed selection and storage.
- Identify suitable seed source trees near the host farmer's Forest Garden for Activity 2. The trees may be in the general vicinity, and the group will not be looking at newly planted trees in the Forest Garden, as these trees will not yet be mature enough for seed collection.
- Identify a garden where either the open-pollinated plants are beginning to fruit, or where the fruits are beginning to ripen, so that farmers can identify plants with the best qualities.
- Identify a secure and appropriate site for drying and storing seeds.
- Identify and collect dry and wet seeds for processing and tools needed for Activity 3.
- Collect and sterilize containers for seed storage in Activity 5
- Begin a small germination test to have ready to show (early enough that the seeds will already have germinated)

*Day of the workshop:*

- Set up the seed processing stations in a shady and protected area.
- Set up the containers and sterilization station near the seed processing stations.

## Supplies

- ☐ Flipchart paper (also for germination test) and markers
- ☐ Dry seed and wet seed in relevant quantities for Activity 3
- ☐ 10-15 sterilized jars or seed containers
- ☐ 1-2 containers for germination tests
- ☐ Masking tape or other stickers or material for labels.
- ☐ Fine point marker or pen
- ☐ Materials for sterilization of containers
- ☐ Paper towels
- ☐ Desiccant (0.5 kg of rice or ash)
- ☐ Large tarp to lay beneath a tree for seed collection
- ☐ Pruning tool or rakes to harvest seed.
- ☐ Sieve for sifting debris. Specialized tools, rocks, hammers or soaking for difficult extraction.

## Total Time

Approximately 3.25 hours

## Seed Saving

### Summary of Activities

**Opener:** Seed Saving Introduction and Germination Tests (30 minutes)

- Introduce workshop topic
- Seed Viability
- Small groups practice germination tests

**Activity 1:** Storing Seeds (30 minutes)

- Appropriate storage locations and containers
- Making labels and storing seed

**Activity 2:** Vegetable Seed Source Walk (30 min)

- Identifying seed sources for vegetables
- Marking vegetable source plants
- Small groups practice marking source plants

**Activity 3:** Tree Seed Source Walk (30 min)

- Identifying seed source trees
- Collecting seed from seed source trees

**Activity 4:** Extracting and Processing Tree and Vegetable seeds (1 hour)

- Dry seed processing demonstration and discussion
- Small group dry seed processing stations
- Wet seed processing demonstration and discussion
- Small group dry seed processing stations

**Activity 5:** Seed Bank Planning and Workshop Closure (30 min)

- Seed Banks Opportunities
- Optional: Group Seed Bank Planning
- Paired Planning of Take Home Activity: Setting up a Household Seed Bank
- Review introduced concepts
- Farmer Evaluation of the Workshop

## Opener: Seed Saving Introduction and Germination Test (30 minutes)

### Description

The group is introduced to the workshop topic and discusses the benefits of seed saving. Following this, Farmers learn why a germination test is important for seed saving, which seeds might most need one, and observe a germination test process, which they will practice with the technician or lead farmer at the follow up.

### Instructions

#### 1. Introduce the practice of seed saving

Ask the group what seed saving is, who saves seeds and what kind, to gauge the level of experience of the group. Emphasize that it's possible to save many types of seeds, not just field crop seeds.

- What is seed saving? (The process of harvesting seeds from grown crops to plant or store for later planting.)
- What seeds do you currently save?
- What kind of plants can you collect seeds from? (field crop, vegetables, and trees)

Ask why it is preferable to save rather than purchase seeds each season.

- What are the advantages of seed saving?
- What are some disadvantages? Are there some seeds which are easiest to buy rather than try to save?
- What are the most popular seeds to save?
- What are some of the challenges you have faced with seed?
- What seeds do you want to save this year?
  - Which are important for your household nutrition? Which crops will provide good market opportunity? Which seeds are the most expensive and will save you money if you save them?
  - What other reasons might you have for deciding which seeds to save?

#### 2. Germination Tests

One of the key factors in seed saving success is viability.

- What is seed viability?
- How do you know whether a seed is viable?
- How does heat and time affect seed viability/germination?
- Has anyone had the experience of planting a lot of seed and then it not germinating?
- Is there a way you can know if seed is viable before planting a lot of it?



Introduce the concept of a germination test. The large group looks at a germination test that has already been conducted and is sprouting, and then breaks into small groups to practice doing a germination test.

- What is a germination test?
- Why are germination tests done?
- How often should you do a germination test with your seed collection?
- Should you test every type of seed in your collection?
- Which seed varieties are most important to do a germination test for? (seeds that you plant a whole field of, seeds that take a long time to germinate--avoid wasted time; not as necessary for fast germinating seeds)
- What do you do if the germination test has poor results?

The facilitator wraps up the exercise by explaining that all the skills that will be learned in the workshop today will ensure the highest level of seed viability.

## Activity 1: Storing Seeds (30 minutes)

### Description

The facilitator leads the group in setting up a home seed bank, talking about principles of seed storage and identifying specific storage criteria for the seeds they will extract in Activity 4. Farmers identify a good location for storing seeds at the host farmer's home, and then clean, correctly label and store the seeds extracted in Activity 3.

### Instructions

#### **1. Where to store seeds? Identifying a location and preparing containers.**

Before we will identify source plants, collect and process seeds, we want to think about the proper storage location and proper containers. Ask farmers what experience they have had in storing seeds.

- From what do you need to protect seeds (children, animals, pests, moisture)
- How can you protect them from these things?

Ask the group what kind of containers are best for storing seeds, and pass around several types of locally relevant containers that could be used to store seeds. Practice sterilizing the containers using the provided supplies and set them up to dry. *\*\*If it is humid and there is not enough time for them to dry after sterilizing and doing step 2, they may sterilize a few, and then practice labeling and filling other pre-sterilized ones.*

- Does seed storage require specialty containers?
- What are the best characteristics of containers and why? (color, size, airtightness, security, stackability).
- Where can you find containers for storing seeds?



- Why do we need to sterilize containers?
- How do we prepare/sanitize storage containers before putting seed in?

Guide the group of farmers to a good storage location near the Forest Garden, if one exists. This might be a room or cabinet in a home or a shed.

- In what kind of space should stored seeds be kept?
- Should the space be in a bright area or a shaded area?
- What temperature does the space need to be?
- What should the moisture level of the space be?

The group looks at the site identified at the lead farmer for a seed bank and discusses whether this location meets the needs for seed storage listed above.

## **2. Labelling Containers and Storing the Seeds**

The group returns to the location of the sterilized containers. Ask the group what information should be on the labels and discuss why.

- What is the best way to make labels and attach them to the containers?
- What information should go on the labels?
- Why is this information important?
- How full should you fill the containers with seeds?
- How can you prevent pests from damaging the stored seeds? (neem)
- How dry do seeds need to be before storing?
- What might you use as a desiccant? (dry rice, ash, milk powder, other options?)
- Are there some seeds that require different amounts of moisture? (Talk about different requirements for the seeds you are working with) How can you handle that?
- How do you store seeds that require some moisture for viability?
- How often should seed be collected to add to the seed collection? How often should old seed be disposed of?
- Do you add newly collected seeds to containers of old seed?
- How long can the seed last in storage while remaining viable?

## **Activity 2: Vegetable Seed Sources (30 minutes)**

### **Description**

The group moves to the garden area, and practices identifying and marking vegetable plants for source seed. At this stage, farmers will likely be looking to identify the plants that fruit first or the plants that have the most fruit ready to harvest. This gives farmers time to mark and save their maturing vegetable mother plants in their gardens.

### **Instructions**



### **1. Identify source plants for vegetables**

The facilitator leads the group to the vegetable plot and asks the group to identify plants that are good potential seed sources, starting with one of the selected crops.

- What are some important things to consider when selecting seed source plants for vegetables? (size/strength/health of the plant, size of fruit, early fruiting).
- What are some characteristics to avoid when selecting a seed source for vegetables?
- How should you think about pests when identifying source plants for vegetables? Are there any plants that seem to be less impacted by pests in the garden? (Pest resistance can be genetic--so select plants that have less pest infestation)
- How many potential seed source plants should you identify and save per type (for instance 2-3 tomato plants? 2-3 pepper plants? 3-4 amaranth plants?)
- What Forest Garden vegetable crops should you start saving regularly?
- Are you saving all the vegetable crops and colors that make up a nutritious meal? Go through all five colors - red, orange, light green, green leaves, and brown legumes - to ensure farmers account for each group.

The group discusses hybrid plants and the challenge/discouragement of saving seeds from them, and identifies which open source vegetable seeds will be good to save.

- What are hybrid seeds?
- Is it possible/good practice to save and replant hybrid seeds?
- Can you use vegetables from the market as a seed source?
- What are the most important things to consider when selecting vegetables from the market for vegetable seed?

### **2. Mark vegetable source plants**

Now we will look at how to mark vegetable plants that you have identified as being good seed source material.

- How do you mark vegetable plants as seed sources?
- What can you use to mark it? (ribbons, stakes, shredded fabric)
- At what point in the vegetable plant's life should you mark it?
- How should you care for that plant once you have marked it? (Depending on the species, farmers may want to give it extra attention, water, weeding, compost to ensure it will continue to grow healthy and produce good quality seeds)
- Can you harvest fruit from plants you have identified as a seed source?
- How many vegetable source plants of each variety should you mark/save for seed saving?

### **3. Small groups practice marking plants**



The group then divides into 4-5 small groups and each small group is assigned a different crop (tomatoes, squash, beans, greens, pepper, eggplant) for which they will mark good source plants, using the process just taught. Following this, the large group reconvenes and each group presents what they have marked and explains why. The facilitator can add any species specific information at each crop. They finish by talking about when they anticipate harvesting the seed for each one.

- When is the best time to collect vegetable seeds?
- Should you harvest when the fruit is ripe or past ripe?
- Should you harvest the first fruits or last fruits?
- How many fruits from each plant?

## Activity 3: Tree Seed Sources and Collection (30 minutes)

### Description

The facilitator leads the group on a walk around the farm or surrounding area where there will be seeds to collect from mature trees. Farmers learn how to identify a good mother plant and then learn and practice the best way to harvest seeds from 2-3 mother trees of agroforestry or forestry species.

### Instructions

#### 1. Identify seed source trees

Guide the large group to a specific tree with seeds in the area, and discuss identification and characteristics of a good source tree using the tree as an example.

- What do healthy and productive trees look like? What is their form?
- What characteristics should source trees have? What should you look for in terms of crown shape, trunk, size, rate of growth, and overall health?
- When does the tree produce seeds? When are they ready for collection?
  - Best to collect seeds from mature pods that have not yet opened.
- Should seeds be from young or old trees? How old/big should the trees be for collecting seeds?
- What are some characteristics to avoid when selecting a seed source tree?
- Should you collect all your seeds from one tree?

#### 2. Collect seeds from source trees

Demonstrate best methods of collecting seeds from source trees and guide farmers in collecting seeds.

- Where should you harvest on the tree?



- What is the best way to remove seeds from the tree?
- Should you collect seeds from the ground?
- How might you use a tarp below a tree in seed collection?
- What are the best containers to put seeds in when collecting?
- What can you do to avoid bugs from being collected with the seeds/seed pods?

### 3. Visit a second species and repeat the process of identification and collection

### 4. Bring back the collected seeds for use in Activity 3.

## Activity 4: Extracting and Processing Seeds (1 hour)

### Description

Farmers rotate through stations practicing proper processing of dry and wet vegetable and/or tree seed, including grading, pest prevention, and extraction tips, targeting the most challenging things.

### Instructions

#### 1. Dry Seed Processing Demonstration

Move to the dry seed processing area, where locally relevant dry seed materials from 4-6 trees and/or vegetables are provided at different stations, including those collected during Activity 2 (e.g. Calliandra, Leucaena, Acacia nilotica, Cajanus cajan, okra, okra, okra, etc.)

***\*Dry seed materials** means that if in a pod, the pod is included, if in a flower head, the flower head is included. The seed should be as it would be if farmers were collecting it from the plant.*

- Now we will work on extracting and processing seed for storage.
- Why are dry seeds often considered easier to harvest than wet seeds?
- What tools should be avoided because they could damage the seed viability? (mortar and pestle, threshing machines, shelling machines)
- Should the seed be placed in the sun for drying or to help open the pods? What is the concern with this?

Invite farmers who have experience processing seed from any of the selected plants to demonstrate the process for the group. Many farmers already have dry seed processing skills. The facilitator fills in and demonstrates the process for any of the remaining species and technical support is focused on the more challenging aspects of seed processing with attention to grading seed, pest damage, and tricks for easy extraction and processing.

- How do we remove the seeds from shells and pods without damaging them?
- At what stage should the fruit/pod be before removing the seed?



- What should this seed look like? (Facilitator should collect an example of a good and bad seed ahead of time.)
  - An example of a good seed for this species? (Pass it around)
  - An example of a bad seed for this species? (Pass it around)
- How can you clean the seed with a sieve?
- How can you winnow to remove debris, particularly with smaller seeds?
- What can you do to protect the seeds from insects during storage?
- Should anything else be done to prepare the seed for storage?
- How should seed be graded and sorted?

## 2. Small Groups practice dry seed extraction

Divide the group into small groups and have each group start at one station to practice extracting seed with facilitator's offering support. The groups create labels for all the seeds they processed and then fill the containers. Wet seeds should be dried if necessary and placed to dry for future storage. During this process continue a discussion about other storage considerations begun earlier. Have groups rotate after 5 minutes at each station.

## 3. Wet Seed Extraction Demonstration

Move to the wet seed processing area, where locally relevant dry seed materials from 4-6 trees and/or vegetables are provided at different stations. ***\*Wet seed** is seed surrounded by pulp that must be manually separated (eg. traditional tomatoes, traditional eggplant, peppers, pumpkin, papaya, guava).*

- Now we will work on extracting wet seeds.
- Why might wet seed processing be more challenging than dry seed processing?
- What challenges have you encountered?
- What special considerations are involved with wet seed processing?

Invite farmers who have experience processing seed from any of the selected plants to demonstrate the process for the group, and fill in and demonstrate the process for any of the remaining species. Technical support should be focused on the more challenging aspects of seed processing with attention to grading seed, pest damage, and tricks for easy extraction.

- How do we remove the seeds without damaging them? (specific techniques for each type)
- At what stage should the fruit be before removing the seed?
- What are some good methods for removing seeds from their pulp?
  - Scraping the seeds out and washing them
  - Mashing the material and soaking it in water to separate the seeds (How long should you soak them?)
  - Any local/traditional methods that are sometimes used?
- Should seeds be washed after removing the pulp?



- Why must we be careful when drying seed in the sun?
- What should this seed look like?
  - An example of a good seed for this species? (Pass it around)
  - An example of a bad seed for this species? (Pass it around)
- Do the plants show any warning signs for pests or disease?
- Do we know where these seeds came from? Why is that important?
- Should anything else be done to prepare the seed for storage? (drying, how long, other details)

#### **4. Small Groups Practice Wet Seed Extraction**

Break the large group into 3-4 small groups who rotate through different stations for 5 minutes at each station, to practice processing each type of seed with technicians offering support. The groups create labels for all the seeds they processed and then fill the containers. Wet seeds should be dried if necessary and placed to dry for future storage. During this process continue a discussion about other storage considerations begun earlier.

## **Activity 5: Seed Bank Planning and Workshop Closure (30 minutes)**

### **Description**

To close the workshop the facilitator shares the concept of group seed banks and the group decides whether to set up a group seed bank or individual seed banks. As a group or individually they identify what seed they will be saving this year and get information on how to store them properly.

#### **1. Seed Bank Opportunities**

Some groups may decide to save seeds collectively if individual farmers do not have adequate storage options or if there are certain seeds for which they need to save in larger quantities. Discuss the benefits of saving some seeds as a group and determine if the group would like to have a group Seed Bank.

- What are different arrangements of seed banks (individual, group, regional)
- What are the benefits of group seed banks?
- What are the benefits of individual household seed banks?
- What are the business opportunities in seed banks?
- Reminder: TREES will no longer provide seeds in the 3rd and 4th year.

#### **2. Optional: Group Seed Bank Planning**



For groups that decide to have a group seed bank, support them in planning the next steps to set this up. This may be done with the Group Farmer Leader.

- If developing a group seed bank, how will you divide up the types?
- Who will grow what? Who will collect what?
- For group seed banks, why is it important to have more than one person saving each type of seed?
- Will the group bank be held in individual homes or one central location?
- When will you set this up together?

### **3. Paired Planning for Take-Home Activity: Setting up a Household Seed Bank**

Have the group pair up and share with each other how they will begin to set up their household seed bank which is their take-home activity. Each participant should identify 3-5 vegetable seeds representing a nutritious diet, 3 agroforestry tree seeds, and at least one fruit tree seed they would like to save, based on their nursery and garden plan for the year and what was learned in the workshop. Support the pairs by providing information about the harvesting, and storage of each seed chosen.

- Which seeds will you save this year? Which seeds do you need for your agroforestry tree nursery? Which fruit or timber tree seeds will you save? Which vegetable seeds do you need for your permagarden?
- Where will you collect the seeds you will be saving this year?
- When will you do your first collection?
- Do you have access to containers? Where will you get them?
- Where will you store the seeds?
- What are the processing and storage requirements for these seeds you have selected?

### **4. Review introduced concepts**

Gather the group together again and take 10 minutes to check for understanding and discuss anything that is unclear.

- What are the characteristics of a good source plant?
- What are 3 important steps in collecting seeds?
- What are 3 important steps in storing seeds?
- What information needs to be on the labels for seeds?

### **5. Farmer workshop evaluation/feedback**

The facilitator asks participants a series of questions in order to evaluate the success of the workshop and identify areas for improvement.

- What questions do you have?
- What was the best/most important thing you learned today? What went well?
- Is there anything that is not clear? What could be improved?

## Take Home Activity: Create Your Own Seed Bank

### Description

Each farmer will create their own household seed bank. Farmers may decide that they would like to work as a group if there are not adequate resources on an individual level, however the objective is that all farmers have a household seed bank. Following the workshop, the beginning seed bank should have 4 different vegetable types representing a diverse and nutritious diet including greens, nightshades (tomato, eggplant, pepper), beans, and squash. It should also have seed collected from 3 agroforestry species trees that will be propagated in the nursery the following year, to fill gaps in the Green Wall and Alleys/Contours and one fruit tree species.

In the following year, farmers should be saving all open pollinated vegetables that they grow in their garden as well as all agroforestry seed species that they will be propagating that year and two fruit tree species.

The facilitator or lead farmer will choose two times to check on the progress of the seed bank over the next year, including one time around tree seed harvest and one around vegetable seed harvest.

### Instructions

#### By the next visit:

1. Identify an appropriate location for housing the seed bank
2. Collect your seed storage containers, materials for labelling and materials for natural pest repellent
3. Mark vegetable source plants
4. Identify Tree Seed Source Plants and collect agroforestry seeds
5. Process and store collected tree seeds in the seed bank

#### By the following visit:

1. Harvest seed from vegetable source plants
2. Process and store collected vegetable seed in the seed bank

#### Additional for groups:

- Initial group meeting and plan for future meetings
- Design of the seed bank (is it simply a central warehouse for individual farmers' seeds or a club for seed sharing?)
- Agreed location/plan for security
- Seed production task assigned to each member (who is producing what?)
- Material provision (who is providing containers, which ones, other needed materials-- desiccant, labels, natural pesticide, etc.)



- Management tasks assigned to members

## Follow-up

The lead farmer should visit when the seed bank has been set up, seeds have been harvested and stored to ensure that the seed bank meets required characteristics. During this visit, the lead farmer and farmer practice conducting a germination test using a very small amount of stored seed. Following vegetable seed saving, the lead farmer will check the permagarden to see that the farmer has marked plants that will be set aside for future seed collection. Additionally, each individual or group should be visited around the time the seeds will be planted next season to assess the storage and germination, and provide advice on planting and harvesting for future seasons.

## Seed Saving Performance Measurement Checklist

As a result of this training, it will be observed that the farmer has:

### General

- ☐ Set up a personal home seed bank in a good location
- ☐ Collected and be using appropriate containers
- ☐ Correctly labelled containers including species (local name is fine), location of harvest, date.
- ☐ Properly processed seed for storage
- ☐ A verbal plan for future harvest and replenishment of seeds.

### Tree

- ☐ Started saving 3 agroforestry tree seeds

### Vegetable

- ☐ Properly marked potential mother plants from which to harvest seeds
- ☐ Started saving 3 vegetable seeds

## Water Conservation



## Goal

Farmers will learn how to maximize the use of rainwater throughout their Forest Gardens. Farmers will expand upon technologies and earthworks introduced in previous modules while developing new techniques for directing, distributing, and capturing water throughout the Forest Garden.

## Learning Objectives

By the end of this workshop, farmers will be able to:

1. Understand and explain how rainwater behaves and moves throughout their own Forest Garden, identifying wet or dry areas of the field, erosion prone areas, and topography.
2. Continue use of mulching in permagardens and around high-value trees.
3. Build advanced earthworks (boomerang berms, check dams, and cuvettes) that control runoff, erosion, and evaporation and adapt cuvettes as fruit trees grow.
4. Plant vegetative strips in erosion prone areas, using rocks, digging berms and swales, and planting grasses (vetiver/napier) and other perennials.
5. **Optional/Modular, based on region:** Implement another advanced water management system (water catchment, water redirection).

## Venue and Timing

This workshop takes place in Year 2 at the beginning of the rainy season, when the ground is a bit soft, but still early enough to establish techniques for water management. The Flex Activity: Using an A-Frame will be done in conjunction with this module for regions that did not do it in Outplanting. A host farm should be selected that has some topography, signs of erosion and some fruit trees planted in a slightly sloping area.

## New Concepts and Vocabulary

Facilitators should prepare these words and concepts ahead of time so they know how to accurately describe these things in local and appropriate language, during the course of the activity.

- Erosion
- Evaporation
- Runoff
- Water Table
- Garden Earthworks
- Check Dam



- Vegetative Strip
- Diversion Swale or Channel
- Microclimate
- Cistern or reservoir (optional)
- Water Catchment
- Catchment pond (optional)

## Preparation

- Talk with the lead farmer and host farmer to identify a host farmer whose field shows signs of erosion and who is planning to install a catchment installation or other major water conservation initiative.
- Talk with the host farmer about garden earthworks and waterflow of their Forest Garden ahead of the workshop
  - Identify problem areas that will be used for swales and vegetative strips.
  - Prepare the plants that will be used to plant the vegetative strips.
  - Gather enough compost to fill cuvettes and enough mulch to cover them.
  - Identify and mark the fruit trees that will be used for the enlargement of the cuvettes and installation of boomerang berms (ideally 5-6 of each).

## Supplies

- ☐ Plant material for vegetative strips
- ☐ 3-4 A-frames (or all materials necessary if doing the Flex Activity: Making and Using an A-frame)
- ☐ Optional, depending on region: Rainwater catchment supplies
  - 1-2 rain barrels
  - Appropriate gutters, pipes, and fasteners
  - Construction tools/supplies
  - Catchment pond liner and clay soil (if catchment pond is appropriate)
- ☐ ~5 dig axes
- ☐ ~5 spades
- ☐ Compost, material to serve as mulch.

## Total Time

~4.25 hours

# Water Conservation

## Summary of Activities



**Opener: Water Runoff and Infiltration (20 min)**

- Demonstration of how water infiltrates different types of soil
- Discuss water issues in the area and possible solutions

**Activity 1: Field Water Assessment (30 min)**

- Observe the training site/host farmer's field
- Discuss what solutions are applicable
- Microclimates, drought- and water-tolerant crops
- Update Forest Garden Design of Host Farmer

**Activity 2: Advanced Water Conservation Earthworks: Cuvettes and Half-Moon Berms (30 minutes)**

- Enlarging Cuvettes as trees grow
- Installing Half-Moon Berms
- Mulching
- Small groups practice enlarging cuvettes, establishing half-moon berms, and mulching

**Activity 3: Advanced Water Conservation Earthworks: Vegetative Strips, Check Dams and Diversion Swales (1 hour)**

- Vegetative Strips
- Review of Marking Contours OR (Optional) Insert Flexible Activity: How to Construct and Use and A-frame
- Planting Vegetative Strips
- Constructing small Check Dams for Small Gullies
- Diversion Swales
- Small groups practice constructing small check dams, diversion swales and planting vegetative strips

**Activity 4: Water Catchment (1 hour)**

- Benefits of Water Catchment Systems
- Installing a system
- Estimating water capture
- Water Quality, Safety and Health

**Activity 5: Smart Water Distribution (30 minutes)**

- Discuss irrigation practices
- Two Water Distribution Techniques: Discuss or demonstrate drip irrigation

**Activity 6: Paired Forest Garden Design and Workshop Closure (15 min)**

- Paired Forest Garden Review--Adding water conservation techniques
- Debrief on workshop topics
- Participants evaluate the workshop



## Opener: Water Runoff and Infiltration (20 min)

### Description

The group begins by discussing the water challenges they experience and they share solutions they have used. Begin with a live demonstration that involves moving water through or across plastic bottles and trays filled with varying soil types. Invite the farmers to recall the lessons of the water infiltration activity conducted during the composting workshop. Help them recall that water infiltrates the soil at different rates depending on how much organic matter is in the soil. Then the facilitator demonstrates the effect of bare soil, ground cover and slope on water runoff and infiltration, using 3 example demonstration trays: one with bare soil, one with brown mulch, and one with a living groundcover of grass. (If no demonstration trays are available, they can do the demonstration on the ground, selecting similar areas with similar slope, and adding the mulch or grass.)

### Instructions

#### **1. Discuss water issues in the area and possible solutions**

The facilitator introduces the workshop topic and leads a discussion on why water is so important. Farmers volunteer their experiences with water issues in the area and detail some methods they have traditionally used to deal with them.

- Why is water so important to agriculture?
- Is water difficult to obtain at times?
- How is water lost? Through consumption? Evaporation? Runoff?
- What are some techniques that we already do to conserve water?
- In what other ways can we capture and control water?

#### **2. Review effect of good soil on water infiltration**

Start by reminding the group about the water infiltration demonstration they did in the Composting module.

- Remember how different soil types affect water infiltration?
- What happens to water in good soil?
- What happens to water in poor soil? (either flows through sand too quickly or pools on top of the clay)
- What is one of the ways that can improve water infiltration? (building healthier soil through compost and organic matter)



### **3. Groundcover and water runoff**

Regardless of soil type, it is also important to cover bare soil in order to prevent runoff. Raise one end of each of the three demonstration trays very slightly so there is a slight slope. Pour the same quantity of water over each trays and have the group observe the difference.

- What happens to the water in each of the trays?
- Which tray has the least runoff and most water infiltration?
- Why is it important to prevent runoff when it rains? (gives more time for water to infiltrate the soil and be available for plants; prevents good topsoil from leaving the farm)
- What is another way mulch and ground cover help with water conservation? (they help prevent water evaporation)

After pouring water one time, raise the tray a bit more to increase the slope and repeat.

- What do you notice about the water and the soil when we raise the tray (increase the slope) even more?
- Are there any gullies that start to form?
- How can you relate this to the Forest Garden?

Our goal is to cover the ground with living groundcover--plants--which will help hold the soil and prevent runoff. In places where there is bare soil, like the garden bed, we must cover the bare soil with mulch.

### **4. Demonstrate water runoff with micro earthworks**

Using the bare soil tray (or on the ground), construct some mini boomerang berms and long contour berms. Pour water onto it again and have farmers observe the flow of the water and the effect of these mini earthworks.

- How do earthworks help with water infiltration?
- What kind of earthworks do you already have in your Forest Gardens?

We know that it is important to increase vegetative cover of the soil. We will begin this workshop developing advanced earthworks. Then we will learn how to install water catchment systems and talk about smart water distribution systems and plant selection.

## Activity 1: Field Water Assessment (30 min)

### Description

Farmers walk around the lead farmer's field in small groups and observe signs of water movement and problem areas that might need to be addressed. They are instructed to feel the soil in different areas and observe the slope, groundcover, any gullies or erosion, and water around young fruit trees. Each group comes back and reports what they observed. They then briefly discuss some potential solutions before beginning to install advanced earthworks in the areas they identified.

### Instructions

#### **1. Small groups do a field observation walk for water issues**

Divide the group into small groups and have them walk through the field to observe the following things:

- Slope
- Existence of swales and berms on contour (are they working successfully?)
- Areas of evidence of water flow (debris left behind)
- Areas of visible erosion
- The level of bare soil and groundcover through the forest garden, and especially the permagarden
- Areas that are prone to flooding or have a very high water table.
- Areas that might experience more evaporation (the combination of no ground cover and lots of sunlight)
- The ground around young fruit trees

#### **2. Small groups return to discuss their observations**

Each group shares a few of the areas they observed as they walked through the field together. They point out the major areas of erosion and evaporation and suggest some possible solutions. Ask the host farmer to share any other challenges that the group did not notice.

- What technologies might help manage water in this field and in these problem areas?
- How could we conserve water if water is scarce?
- How could we control water if the water table is too high or the area is prone to flooding?
- Could a catchment be used? What should it look like and where might it be placed?
- To the host farmer: what other water challenges do you experience? Where are the problem areas of the field?

### 3. Microclimates and drought- and flood-tolerant crops

The facilitator introduces the concept of a microclimate. As people describe areas that were flooded or very dry, the facilitator asks which crops are traditionally known to be drought tolerant and which are known to be flood tolerant and might be able to be grown in that part of the field. The facilitator may want to write the list on the flipchart and identify any relevant crops that have not been discussed and introduce them.

- What is a **microclimate**?
- How many different microclimates might you have in your Forest Garden?
- What crops do well in wet areas?
- Where would you plant those crops at this site to take advantage of their flooding resistance?
- What crops do well in dry areas?
- Where would you plant those crops at this site to take advantage of their drought resistance?
- What would happen to the wet areas in the dry season? Would the drought tolerant crops do well there?

### 4. Update the Forest Garden Design of the Host Farmer

Using observations about the flow of water at the training site, with the host farmer, discuss the direction of the flow of the water and the perpendicular orientation of the contour rows and berms. Add the required additional contour lines to the Forest Garden design in areas that experience higher water flow. Add any other major points about water identified by the group. After the waterflow has been depicted, the group should advise where each identified water conservation technology should go. Share that the group will spend the next few activities working on garden earthwork solutions for these challenges that you have identified.

## Activity 2: Advanced Water Conservation Earthworks: Cuvettes and Half-Moon Berms for High Value Trees (30 min)

### Description

The facilitator shares that cuvettes need to be enlarged as the trees grow to maintain their effectiveness. The facilitator then reviews where cuvettes are placed in relation to the branches and demonstrates the process of making the cuvette bigger. They then look at some fruit trees planted on a slope and learn about the installation of boomerang berms. Farmers then rotate



through stations to work on the following techniques: adapting cuvettes for growing trees and installing boomerang berms.

## Instructions

### 1. Enlarging Cuvettes

Gather the farmers around a young fruit tree with an already established cuvette. Explain that cuvettes have to be enlarged as fruit trees grow in order to be effective.

- What is a cuvette and what is its purpose?
- How often should you enlarge it?
- Where should the cuvette be?
- Why is it important to avoid digging down to create the cuvette but rather to build the berms upward?
- How often should you enlarge it?
- How long should water stand in the cuvette?
- What should you do if water is standing for too long?

### 2. Installing Half-Moon Berms

Move the group to an area with fruit trees planted on slightly sloping land. Explain what a half-moon berm is, and why it is a preferred technology to cuvettes for fruit trees planted on a slope. Demonstrate how to install one.

- What is a half-moon berm?
- Are there any other materials that can be used for constructing them? (you can add rocks or pieces of wood, as well as soil)
- How big should it be? How far out past the tree canopy should it extend?
- How far above the tree on the slope should it extend?
- How can half-moon berms connect and flow into each other?

### 3. Mulching

Still looking at the fruit trees, talk about mulching. Discuss mulching practices for permagarden beds as well. If the permagarden area is right next to the fruit trees, then mulching can be demonstrated in those beds as well.

- What should you fill in the middle of cuvettes?
- How does mulch improve water conservation?
- Can you mulch inside of boomerang berms?
- What makes the best mulch?
- How thick should mulch be applied?



- Should you mulch right up to the tree?
- Should you use similar or different material for mulching inside cuvettes than what is used on permagarden beds?
- Is the technique of mulching different on permagarden beds?
- What is the best timing for mulching permagarden beds for direct seeded plants or transplanted seedlings? (before germination, before transplanting, after germination, after plants are a certain age)

#### **4. Small groups practice**

Divide the group into 4-5 small groups and have them practice enlarging cuvettes, installing half-moon berms, and mulching to complete 10 different tree locations (5 of each).

### **Activity 3: Advanced Water Conservation Earthworks: Vegetative Strips, Check Dams, and Diversion Swales (1.5 hours)**

#### **Description**

Using one of the erosion or gully areas identified in the Field Observation walk, the group learns how to build small berm check dams and swales, creating diversion swales and how to plant vegetative strips of grasses and other perennials. For areas with frequent inundation, work will be done on diversion swales to move water out of cultivation areas (connecting to a catchment).

#### **Instructions**

##### **1. Installing Vegetative Strips**

Move the group to one of the areas of slight erosion or evidence of water flow (debris) across the land. Explain that vegetative strips are a good tool for preventing this kind of erosion, and are appropriate when the slope is not so steep as to require swales and berms.

- What is a vegetative strip?
- How does it help?
- What does it consist of?
- Is it necessary to dig a swale and berm? When should they not be used and a swale and berm system be used instead? (We recommend slopes greater than 10% having a swale and berm with trees; you may want to dig a slight swale and berm for vegetative strips for slopes 5-10%. You can observe how it goes depending on rain events in your area.)



- How many might be installed across the Forest Garden?
- How do you identify where to put it? (transition into the next step)

## **2. Using an A-frame to identify the vegetative strip planting line**

The facilitator uses this time to introduce the A-frame flexible activity or quickly reviews contour lines if the activity has already been introduced in the previous year.

Using an A-frame show how to identify the line for planting a vegetative strip, marking off an area of at least 4 meters.

**OR**

**(Optional) Insert Flex Activity: How to Construct and Use an A-frame**

## **3. Planting the Vegetative strip**

When the line is marked, demonstrate how to plant it with the selected perennial plants. Show how many lines and how deep to plant it, as well as how wide. Looking at the planted line, discuss with the farmers how much longer they should extend it (if at all), observing the field.

- What are the best plants that can be used in strips?
- How close together should plants be planted?
- How many rows or lines should it be?
- How wide should the strip be?
- How long should the strips be?

## **4. Check dams for small gullies**

In areas with small gullies, it may be necessary to do more than a vegetative strip. Demonstrate how to construct them while leading a discussion on the specifics. *Note: small check dams will not solve the problem of large gullies or very sloping land.*

- What are check dams?
- What materials should be used for them? (rocks can be used simply, or wood and other debris could be added, as well as dirt)
- How do you construct them
- What angle should they be to the water flow (exactly perpendicular, not at an angle)?
- Is there any slope in which they should not be used (if the land is too sloping and the gully too deep, they will not be effective).
- How much longer should they be than the gully?
- How wide should they be?
- How tall should they be?
- How often should they be filled or built up?
- What can be planted on them? (similar plants as vegetative strip, as well as larger plants, depending on the size)



- Is there anything that could be planted above them, to make use of the extra water that will collect?
- What will happen to the area over time? (It will fill with sediment and debris to form a terrace, often with good soil quality. A new check dam can continue to be built on top of it over time as the land levels out)

## **5. Diversion Swales**

Move with the group to an area where water needs to be directed out of an area.

In some cases you do not need to catch and hold water in an area, but rather you need to move it out of an area. This may be the case after a heavy rain or if part of your field has a high water table. When possible, water should always be redirected into a holding area where it can be used in the future, rather than moved off of the Forest Garden field.

- What is a diversion swale?
- What angle should it be dug at (in relation to the hillside contour)?
- What happens if the angle is too steep? (the flow will be too high and can cause erosion. The goal is to have water flowing but slowly)
- How deep should it be?
- When should it be dug?
- How can you collect the water after redirecting it out of the immediate area of concern?
- What should be planted on the sides?
- What other techniques might you use for areas with too much water? (raised beds, trenches)

## **6. Small groups practice building small check dams, digging diversion swales, and planting vegetative strips**

Small groups will rotate through 3 stations allowing them to practice constructing each of these techniques.

# **Activity 4: Water Catchment (1 hour)**

## **Description**

There are two main techniques that can be taught in this section: water catchment off a roof and water catchment in a small pond. Each facilitation team will decide, in conjunction with the lead farmers, which technique will be more relevant to the farmer groups they are training. After walking through the steps of installing one of these systems, the facilitator reviews some considerations when designing catchment systems, the facilitator explains a simple method for calculating water needs and shows how those needs might determine the size of an on-farm water catchment.



## Instructions

### 1. The benefits of a water catchment system

Now that we have looked at shaping the earth to help direct, slow and sink water moving across the field, we will look at how to capture and store rainwater.

- Can we capture and store clean water in times of plenty to be used in times of need? What are some water catchment systems you have seen?
- Does anyone currently have a rainwater catchment system? What kind? When did you install it?
- What are the major benefits of having a water catchment system?
- What are some of the challenges of it?

### 2. Install a catchment system: roof capture cistern or catchment pond

Lead the group in working together step-by-step to construct a small catchment system, using the supplies provided and the type identified ahead of the workshop.

#### ***For Roof Capture:***

- What are the steps of constructing this system?
- What kind of roof is best?
- If there is no roof, is it possible to set up a structure to capture rainwater?
- If so, where would this be ideally located? (likely near the permagarden nursery, tree nursery, or permagarden beds where regular watering is required.)
- What kind of containers are best?
- How do you prepare and clean the containers before setting it up?
- How do you keep water clean as it enters the system (regularly clean the roof and gutters)
- What other materials are needed?
- Where might these materials be found or purchased, and how much are they?
- What can be used as a filter for water entering the cistern?
- How can this system run into a drip irrigation system?
- How big should the overflow pipe be? (bigger than the inflow pipe)
- How do you attach other cisterns to capture overflow from the initial one?
- How must you maintain this system?
- How often does the system need to be cleaned? (if large enough to enter, the barrels or cisterns must be cleaned regularly, at least once a year, disinfected with bleach and hand scrubbing).

#### ***For Catchment Ponds or Reservoirs:***

- Where is the best place to locate a catchment pond?
- What materials are needed?
- Where might these materials be found or purchased, and how much are they?

- What are the steps of constructing this system?
- How deep does it need to be?
- How wide does the downslope wall need to be to be strong enough to hold the water?
- What kind of soil is best?
- If you do not have clay soil, where can you access it? How do you layer it onto the bottom?
- How do you compact the soil of the floor and walls?
- How is a dam liner applied?
- Where should the inflow and overflow channels be located?
- How do you direct water into the catchment pond?
- How might one pond be connected to another pond?
- What can be planted along the banks to secure the banks and provide shade to prevent evaporation?
- Are there opportunities for using the pond for growing fish?
- Is it ever ok to consume water from ponds? (no--standing, open surface water like this should not be consumed)
- How must you maintain this system?

### **3. Advanced Activity: Estimating water capture**

The facilitator introduces a simple method for determining water needs and calculating how much rainwater can be captured in a given area.

- How much water do you need?
  - Calculate water use for the lead/host farmer's permagarden beds:
    - Farm or Garden Demand = Water Use (in volume) needed for the farm (or garden) daily and seasonally to get an annual amount (for example: 3 months 10 liters/week; 5 months 20 liters/week; 4 months 30 liters/week=1000 liters/year)
    - Home Demand = Water Use (in volume) x Household Members x 365 days (or number of days during the dry season)
- Determine annual rainfall patterns
  - The facilitator should determine the annual rainfall data alongside the farmers.
  - Rainfall might range from the semi-desert (100-250mm per year) to the wet tropics (over 2000mm per year).
- Calculate potential rainwater supply
  - Map out and measure the area of a typical rooftop or an existing roofed structure which might serve as a rain barrel catchment system. If a catchment pond is likely to be used, measure the expected area of the catchment pond.
  - Supply = Rainfall x Area x Run-off coefficient (the amount of water lost to evaporation or leakage, usually represented as .9 for well-constructed catchment systems)
    - Supply = Mean annual rainwater supply (m<sup>3</sup>)
    - Rainfall = Mean annual rainfall (m)



- Area = Catchment area (m<sup>2</sup>)

#### **4. Water Quality, Safety and Health**

The facilitator leads the group in a discussion about water quality and health, making clear some of the risks and proper treatment of use of water that has been held in a catchment system.

- What is potable water?
- How do we make sure water is clean as it enters the catchment? How do we keep it clean while being stored there?
- Can rainwater stored in a catchment system be used for drinking water?
- What are some ways to make it more safe for consumption?
- What are some ways to protect the stored water from mosquitos and other insects?
- What can be done to prevent algae or bacterial growth in the system from sunlight?
- When using it to water plants, what are some important considerations to make sure the water does not contaminate the plants? (water at the base, don't allow catchment water to touch fruit or edible portions, wash vegetables really well before consuming, especially if consuming raw)
- How can we protect the catchment from children or animals?

### **Activity 5: Smart Water Distribution (30 min)**

#### **Description**

Farmers discuss water distribution best practices (when to water, how much, how) and set up a drip irrigation system or bottle irrigation system with mulching in a permagarden. Farmers discuss plants that are tolerant of flooding and drought and how they might choose to cultivate certain ones in especially dry or inondation-prone areas. Farmers think about microclimates in their Forest Gardens and what they might grow in different areas making use of that. Farmers think about how these microclimates might serve as areas to extend the gardening season. What to plant on the berms as well (other perennials)

#### **Instructions**

##### **1. Discuss when to irrigate**

Assist the group in identifying when it is necessary for farmers to irrigate if rainfall is insufficient.

- Why should we maximize the use of rain and minimize the use of irrigation?
- What time of year are we most likely to need to irrigate water?
- What part of the Forest Garden do you irrigate?
- What is the best time of day to irrigate?



- Where is the best place to actually apply the water on the plants?
- Should you water a little bit every day or a lot every few days?
  - Watering in large amounts every few days helps water penetrate further into the soil and encourage better root growth and trap more water in the Forest Garden. However, some crops (like onions) want stable moisture levels. Mulching can help this. Match the watering type with what the crop needs.
- How does mulching help conserve water?
- What are some signs that plants are in need of supplemental water?
  - Soil properties, discoloration, brittleness, increased pest damage, delayed growth or dieback, reduced yield, etc.

## **2. Two options for smart water distribution: Bottle Irrigation and Drip irrigation**

### ***Bottle Irrigation***

In some cases, you may want to use some water distribution systems that water plants on their own without you watering by hand.

- Has anyone used bottles to water plants?
- When might this technique be used?
- What plants would it be good for?
- How do you set it up?
- How often will they need to be filled?
- Why is it important to move bottles around to different locations or have multiple bottles for larger plants?
- Why is it important to use this only in establishing trees, but not for the long-run?

### ***Drip Irrigation***

If drip irrigation may be relevant or already in use by the group, explain or review the mechanics of drip irrigation systems. The detail of the discussion should depend on the group's interest or situation: ranging from a quick overview to a full demonstration. Explain that this is an effective tool for vegetables, but not a good tool for trees, as the water horizon from the drip irrigation will be small, and will prevent the tree roots from really expanding.

- What is drip irrigation? How does it help conserve the use of supplemental water?
- How do you set up drip irrigation?
- How often should plants be irrigated when on this system?
- Is it appropriate for trees as well as vegetables?
- Does drip irrigation require a large tank? (Small bucket systems can be set up to simply water efficiently though it may not be worth the expense. Catchment ponds and roof catchment systems may be used if they are at a higher elevation than crops.)
- Are there any locally available materials we could use or buy cheaply to build a drip irrigation system?



## Activity 6: Paired Forest Garden Design and Workshop Closure (30 min)

### Description

The Facilitator debriefs the workshop themes. Farmers pair up and look at their designs and identify problem areas where they may use the techniques learned in the workshop, including wet and dry zones, what is planted in each, problem areas and where they will be installing earthworks and/or vegetative strips.

### Instructions

#### **1. Paired Forest Garden Review--Add water flow and technologies to the Forest Garden Design map**

Have farmers pair up to share their Forest Garden Designs, talk about water conservation technologies and update the maps according to what they will be working on. Farmers should answer the following questions and share with each other for each of their maps.

- Which areas of your forest Garden are the wettest microclimate?
- Are there any technologies that you will place there?
- What plants will you grow there?
- Which areas are the driest microclimate?
- Are there any technologies that you will place there?
- What plants will you grow there?
- Where are areas of erosion?
- Where will you be adding vegetative strips?
- Will you need to add any check dams or diversion swales?
- What kind of water catchment will you add? Where will it be?
- Do you have any opportunities for counter-season production on your farm? What are they?

#### **2. Debrief workshop topics (5 min)**

Gather the group together again and review key topics and check for understanding among participants. Any topics that are unclear or concerns that the group may have should be addressed by the facilitator.

- How is the Forest Garden like a sponge?
- What are some techniques to prevent runoff? What are some ways to prevent evaporation?
- How does planting vegetation on our earthworks help to strengthen them?
- What kinds of vegetation are best to plant on or around water conservation earthworks?



- Can you connect multiple earthworks? How would you do it and why would it help? (Overflow channels that direct the water to the next earthwork.)
- How can you keep water clean and safe in water catchment systems?
- Why is it better to grow in the off-season and sell counter to when everyone else is selling?
- What questions do you still have?

### **3. Participants evaluate the workshop**

- What was the most important thing you learned today?
- What could be improved? Any other suggestions?

## **Take Home Activity: Construct Water Conservation Earthworks and Catchments**

### **Description**

Farmers use their knowledge of conservation techniques, garden earthworks, and catchment systems in their individual Forest Gardens. Each farmer will update their cuvettes, add half-moon berms where needed, and install vegetative strips through their Forest Garden. Some farmers will install check dams and diversion swales, and farmers may also install a simple water catchment system.

### **Instructions**

#### **1. Update Cuvettes and Establish Half-Moon Berms**

- Farmers will widen all existing cuvettes on young high value (fruit, timber, etc) trees and establish them on any high value trees that do not yet have them.
- Farmers will establish half-moon berms on any high value trees that are located on a slight slope.

#### **2. Mulch all fruit trees and permagarden beds**

- Farmers will use appropriate material to mulch fruit trees inside cuvettes and half-moon berms at the correct thickness and distance from the trees.
- Farmers will use appropriate material to mulch permagarden beds at the right thickness.

#### **3. Plant vegetative strips**

- Farmers will plant 5 areas of vegetative strips strategically located where they notice water flow, in order to slow and sink the water.

#### **4. Optional, based on need: Construct check dams and diversion swales**

- Farmers will construct check dams in any areas of small to moderate gullies
- Farmers will dig diversion swales in any production areas that are prone to flooding, in order to slowly move the water out of that area.



### 5. Optional, based on region: Create a water catchment

- Farmers will create a simple rain barrel catchment or catchment pond to store water for household or farm use.
  - Farmers should work together with each other and the technician to source materials for water catchment construction.
  - Farmers should also consider setting up drip irrigation systems alongside their catchment systems if possible.

### Follow-up

The lead farmer or technician will visit participants in 2-3 weeks (or another agreed upon time) to check for progress or completion of at least two earthworks and the water catchment.

Farmers should also note any current or future changes in watering or planting techniques.

### Water Conservation Performance Measurement Checklist

As a result of this workshop, farmers will have:

- ☐ Mulched all vegetable beds and fruit trees.
- ☐ Established and/or adapted cuvettes and half-moon berms around fruit trees.
- ☐ Established vegetative strips in erosion-prone areas.
- ☐ **Optional, based on need:** Built advanced earthworks (diversion swales, check dams).
- ☐ **Optional, based on region:** Installed a water catchment system--pond or roof harvesting.



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