AGROFORESTRY

FARMER FIELD SCHOOL

Facilitator's Guide

Jamaica Rural Economy and Ecosystems Adapting to Climate Change (Ja REEACH) Project

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Welcome

April 29, 2013

Dear New Agroforestry Farmer Field School Facilitator,

Congratulations are in order as you approach the completion of the training of trainers, but don't relax too quickly because the fun is only beginning. Implementing your first Agroforestry Farmer Field School will be a transformational experience both for you and for your group of farmers.

We are pleased to be collaborating with RADA and the Forestry Department to launch field schools throughout vulnerable watersheds. The Agroforestry Farmer Field School methodology is a powerful mechanism for building the adaptive capacity of farmers. We thank you for your efforts in using FFS methodology to work with farmers to protect ecosystems and advance environmentally and economically sustainable agroforestry initiatives.

This AFFS training manual contains multiple modules that you can use to conduct your agroforestry field school. Despite the incredible amount of effort that has gone into developing these resources, no two field schools will be the same nor will they received the same series of modules. As a well-trained facilitator you will know how to select the most important modules for each farmer group. You will be able to plan a series of discovery learning activities through the season that will result in powerful learning, sharing and establishment of agroforestry technologies across the agricultural landscape.

The next level in your professional development will be to complete your first AFFS and become a Certified Farmer Field School Facilitator. Once achieving that level of achievement, you will be eligible to undergo advanced training to become a Master FFS Facilitator capable of conducting training of trainers for future facilitators.

There is much we hope to achieve together. We look forward to facilitating widespread learning and empowerment so that our Jamaican farmers can achieve excellence in agroforestry and climate change adaptation.

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Karyll Aitcheson,
Chief of Party
Ja REEACH Project
ACDI/VOCA

Introduction

Jamaica, like many small island developing states, is highly vulnerable to the impacts of climate change. Preliminary climate modeling suggests that Jamaica is likely to see four specific trends: warmer days, variability in precipitation, an increase in the intensity of hurricanes, and changes in sea level. These climatic changes are currently manifested in longer drought periods, changes in crop production cycles, flooding, and increased pest and disease incidences. These impacts are often exacerbated by ongoing economic activities and the unsustainable practices that degrade the quality of the Island's natural resources, on which many rural livelihood activities are based.

Agriculture is one of the dominant livelihood activities in rural areas where production often occurs on marginal lands; contributing to many of the land degradation and environmental problems encountered. The changing climatic conditions threaten the viability of agriculture as many crops are sensitive to changes in temperature and precipitation. It is important therefore, that management options that reduce the risks of climate variability to crop production and increase resilience for small rural farmers be defined, promoted and adopted.

Worldwide there is growing recognition of the valuable role of agroforestry as a climate-smart agricultural solution that uses trees to deliver environmental services (including mitigation of greenhouse gases through sequestration), provides adaptation benefits (by reducing the impact of environmental hazards), and creates additional income sources in rural communities. However, the capacity of rural farmers to apply adaptative strategies is often hindered by finance and an absence of technical knowledge on appropriate innovations.

The Agroforestry Farmer Field School Training Program

Through the Ja REEACH project, ACDI/VOCA partnered with the Forestry Department, the Rural Agricultural Development Authority (RADA), the Tropical Agricultural Research and Higher Education Center (CATIE), and other stakeholders to develop a training program to guide national and local efforts to integrate trees (fruit and timber) within agricultural production areas. The aim of the training program is to equip farmers and group leaders with key information to apply agroforestry innovation and practices to their local situations. This AFFS program, utilizes the Farmer Field School (FFS) adult learning methodology to develop farmers' ability to make critical and informed decisions that lead to more sustainable, climate-resilient and profitable production. Each school is led by a facilitator who is trained to lead field schools following a training of trainer (ToT) process. Through the ToT each facilitator received training in the fundamentals of the FFS adult learning philosophy and methodology which equipped them with improved communication and facilitation skills and strategies for good group dynamics. Each facilitator will use this skillset to lead AFFS sessions with their target farmer group. Each session will be held weekly or biweekly for approximately eight months. The entire training cycle, delivered to the group of farmers, is collectively known as the 'agroforestry farmer field school'.

This Facilitator's guide has five main categories of information:

1. Facilitation tools – which provide the facilitator with a suite of facilitation material ranging from conducting the first AFFS session to close-out and life after AFFS. Dynamic activities are also included to support group engagement and cooperation.

2. AFFS Management Practices – are the technical units covering topics such as climate smart agroforestry systems, agroforestry farm planning, agroforestry ecosystem analysis, planting and protection of seedling, land husbandry, tree nursery management and shade canopy.

3. AFFS Innovations – are the technical units that outline the steps in applying agroforestry solutions such as windbreaks, tropical home gardens, woodlots and fodder banks. Note that the Jamaica Agroforestry Guide provides additional innovations that may be considered by the facilitator following site evaluation.

4. Agroforestry as Business modules are the compiled resources to guide the group in making wise business decisions about the agroforestry plot and strategy employed. The planning module will provide useful baseline information on the potential business opportunities for the farm.

5. Resource material and reference guides (printed and electronic[1]) - represents a compilation of local and international reference material to complement the technical content of the training guide. The innovations and management practices provided in this manual is by no means exhaustive and as such a useful list of additional resources is provided in this manual and on the flash drive provided to you.

Tips on Using This Guide

The modules presented in this guide should not be delivered in order. Facilitators should work with the farmers to understand their needs and design a plan tailored to the needs of the farmers.

The following are some tips:

- The session on climate change is a good module to conduct when there is rainy day early in the field school.

- Try to incorporate the marketing and business planning aspects (chapters 2 and 3) of *Agroforestry as a Business* early in the field school.

- The AFESA activities should be done often throughout the field school, though the core agroforestry topics (shade canopy, home gardens, line plantings etc) have significant mapping and analysis activities so AFESA would be duplicative in effort.

- Time the nursery, planting and protection modules to occur at the appropriate time of the season.

[1] See AFFS resource material on flash drive provided with this guide.

- Invent new discovery learning activities based on farmers' needs. Use the additional resources in the accompanying flash drives for ideas on topics not covered in this guide.

You may contact a member of the Ja REEACH team for help or advice in navigating and further developing these resources.

Contents

Module 1: Welcome to AFFS

Objectives

- To familiarize participants with each other and establish a common understanding of the rules and goals of their AFFS.
- To establish clear expectations of the AFFS and the working and learning relationship among farmers and facilitators where free and frank discussions will lead to a common understanding of what farmers and facilitators hope to gain from the AFFS.

Supplies

- Ball, markers, flipcharts.

Preparation

The first session must be conducted in a way that transfers ownership of the field school to the farmers. This AFFS mobilization process will have already familiarized farmers with AFFS. This session may still be required in order to cover rule making, grouping, and other AFFS setup activities.

When scheduling this module, consider how this module can be delivered in sequence with the following unit to save time.

Venue

This first session can be done individually for each field school group, or it can be facilitated regionally for multiple farmer field school groups. If it is done for single field schools (15-25 farmers), then it can be conducted at a shaded FFS meeting place such as a farmer's house, a shelter, or under the trees in a farmer's plot.

Total Time

Approximately 1.5 hours

Activities

1. Introduction of participants: Tossing the ball. FFS Farmers introduce themselves.
    a. All participants sit down in a large circle.

b. Inform the entire group of AFFS participants that they will have 90 seconds to introduce themselves when the ball is thrown to them. They must tell everyone their name, the types of crops they grow on their farms, and other details they choose, including one fact which no one knows.

c. Instruct the participants to be ready to catch the ball when it is tossed to you. Whoever has the ball introduces herself or himself, and then tosses the ball to another participant who has not yet been introduced. If no ball is available, improvise with a fruit or other object.

2. Give an explanation of *What is Agroforestry Farmer Field School* using Handout 1 as a guide. **(25 minutes)**

3. Take questions about AFFS from farmers **(10 minutes)**

4. Naming small groups **(20 minutes)**

   a. Divide participants into 5 small groups, each with 5 farmers. You may want to start this by having the group count off in fives (1, 2, 3, 4, 5, 1, 2, 3, 4, 5….) and have all the 1s, 2s, 3s, etc. form groups.

> **NOTE** 
> It is probably best for the Facilitator to divide the group up to ensure randomization. This way, participants will have to associate with other farmers they don't already know, and this will result in more effective cooperation within the small group. After these groups are created, tell farmers that if they are already friends or very familiar with others in their group, they will need to change groups.

   b. Have each small group choose a name.

> **NOTE** 
> Use of names for practices consistent with good agricultural practices will help participants remember and identify with those practices. Group names should give a positive impression and be related to horticulture and the crops that we will be focusing on.

   Sample group names:

   - Coconut Palms
   - Gullies
   - Tree tops
   - Nursery nannies
   - Clarendon windbreaks
   - Pimento planters

5. Questions from Farmer Participants about the FFS activities and practices. **(30 minutes)**

NOTE

Though farmers may be energized with questions, resist taking more than 30 minutes to answer questions if additional activities are planned for the day's meeting. Ensure farmers that there will be plenty of time for ample discussion on all topics throughout AFFS.

6. Establish rules. The facilitator facilitates a brainstorming discussion to establish rules for the AFFS.

   Tell the farmers, "It is very important for all participants to respect a common set of rules. Rules that are imposed by outsiders will not be enforced here. This school will be run by rules created mainly by you, the participants/owners. What rules do you want for this group?"

   Write down all the answers on the flipchart and discuss with the group whether each item is appropriate. The following topics should be discussed:

   - When will we meet? What time?
   - Respect
   - Participate
   - Be on time
   - How will we deal with people who are late?
   - We will meet even if it rains!
   - When is absence tolerable? Only in case of emergency.

   Although we have made our own rules, there are some non-negotiable rules that all participants must follow:

   - Respect
   - Participation
   - To graduate, one can miss only one session.

   Display this AFFS rules sheet at every subsequent session.

Daily Summary and Observation Analysis

Reconvene the farmers in a circle at the end of the session. Facilitate the daily summary by asking questions such as:

- What interests you most about agroforestry?
- What observations do you have as you begin an AFFS with a new group?

Handouts

Handout 1: What is Agroforestry Farmer Field School?

HANDOUT 1: What is Agroforestry Farmer Field School?

Welcome to Agroforestry Farmer Field School.

You are all here as members of an Agroforestry Farmer Field School to learn how to use advanced agroforestry techniques to increase productivity in your farms, diversify income streams, and protect your lands from extreme weather. This is in your interest, and it is also in the interests of your families and neighbours who rely on trees for their livelihoods.

The Agroforestry Farmer Field School (AFFS) is a school which takes place in the field. That is where farmers work, so that is where we will all learn. We will be doing many activities and experiments in the field in order to learn better about how to use agroforestry to make money and solve challenges in the ecosystem.

During the AFFS, we will be carrying out many activities in the demonstration plot, known in AFFS as the demplot. What is a Demplot? It is an area of approximately ¼ hectare where we will be practicing techniques. It is our AFFS place for working and learning. We will be doing experiments in the demplot—such as finding out how to grow and plant trees. We will be practicing agroforestry techniques in the demplot—such as how to establish agroforestry technologies and manage seedlings to maturity. And of course, we will be having fun in the demplot. To support the application of best practices on your demplot and farm there are tools and equipment which may be required and if these are not readily available the group may be eligible to receive these small items. These items are provided to the group as a whole so you will have to cooperate in your small groups. You will keep the equipment of your small group secure and safe, and will make sure you have your group equipment for every AFFS meeting.

ROLES

In order for the AFFS to work for us all, we need to be clear on what we are all going to do.

*First, the facilitator - **ME**:* The facilitator will be here once every week or two on the same day according to our agreement and on-time. The facilitator will work with the farmers to ensure we are prepared for the sessions on that day.

*Second, the farmer trainees - **YOU***. You are to be at the AFFS meeting place on the right day at the right time. You personally, Not a substitute (like your son or a friend). We hope you will be serious about learning at the AFFS, because we intend to provide you with a powerful learning experience that has transformed the lives of farmers around the world.

These are the fundamentals of AFFS, and we trust you will find AFFS to be a valuable investment in the future of Jamaican families and environment.

Module 2: Climate-Smart Agroforestry

Objectives

- To identify the challenges resulting from changes in climatic conditions;
- To identify agroforestry solutions to combat the recorded climate change trends;
- To share knowledge about the benefits of trees and application of agroforestry; and
- To generate learning topics for future field school meetings.

Materials

1. Handouts for each farmer
2. Flip Chart Paper
3. Markers
4. Coloured paper
5. Tape

Preparation

- The problem tree should be done as large as possible, preferably with four flip charts papers taped together in a large rectangle.

- Assemble graphical illustrations to represent the trends, effects and solutions.

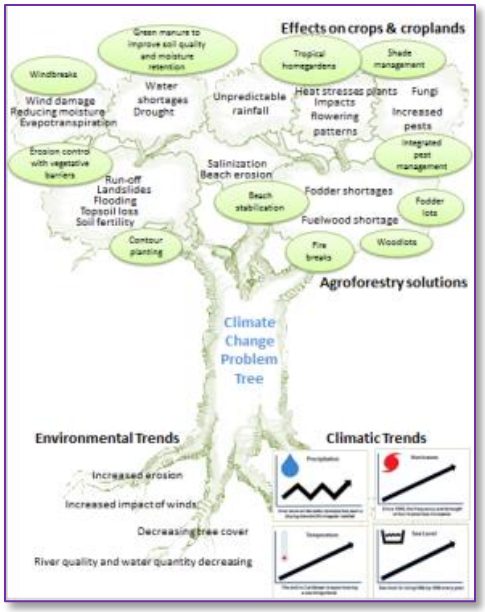
Venue

Inside or outside. This activity needs a large wall space. This can be a rainy day activity.

Time

2 hours

Summary



The result of this module will be the creation of a large problem tree. The activities begin with brainstorming on recent environmental and climate trends which become the roots of the tree. Then the effects of the trends are discussed and they become the leaves of the tree. Finally, farmers brainstorm solutions which become the fruit. The completed result will resemble the example on the right.

NOTE

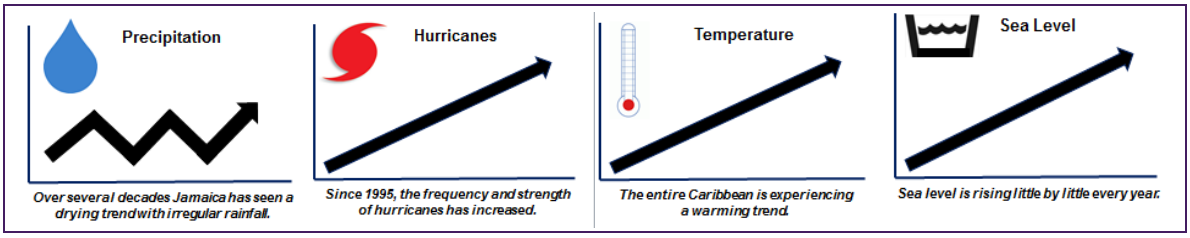
Climate change is a complicated topic. Entire module can be completed without getting too deep into the definitions of climate and climatic changes. Use Handouts 5-8 as guides if discussions with farmers delve into deeper topics related to climate change, weather, vulnerability and resilience.

ACTIVITIES

Activity 1: Trends - Roots

The goal here is to obtain a level of agreement that climate is indeed changing and farmers are witnessing multiple environmental and climatic trends which impact agriculture in Jamaica.

- Instruct farmers to form small groups and consider each environmental element below. They should discuss its state 25 years ago and today. The images of Portia Simpson and Michael Manley are used to signify the time periods.
- Facilitate a reporting out from the groups so that the entire group can come to a consensus on the trends.
- Enter the trends on the bottom of the problem tree. Wherever possible, attempt to draw a graphical interpretation rather than using lots of words.
- Use the four trends pictured at the bottom of the page to assist in the debriefing, but also include any additional trends that farmers have observed.



Activity 2: Detrimental Effects - Leaves

Instruct small groups of farmers to discuss each trend on-by-one and identify several examples of negative effects that these trends have on crops and croplands. These will become the leaves of the tree.

Questions to help identify the effects of the environmental trends:

- What effects do these trends have on agriculture, crops and croplands?

- How do these trends affect crops at various stages in production?
- What do warmer temperatures do to vegetables, coffee and cocoa?
- What effect does the increasing frequency and power of storms have on farmlands?
- How do changing rainfall patterns affect agriculture?
- What is happening as a result of the loss of tree cover?
- What do changes in the flow of streams and rivers have to do with agriculture?
- What does the change in colour of streams and rivers have to do with agriculture?
- What can you say about the quality and quantity of top soil over time resulting from these trends?

Activity 3: Possibilities

Before getting to solutions (the fruit of the tree), take 5 minutes to have the farmers do a rapid brainstorm on tree products and tree services that they are familiar with. This is a way of defining agroforestry without asking farmers to do so specifically.

- Divide the farmers into at least two groups. Instruct one group to brainstorm a list of products and goods that can be obtained from trees. Instruct the other group to brainstorm a list of services that trees can offer.
- Once each group has created a list, tape the two lists on the wall to the left side of the massive problem tree. Use the examples below to prompt the groups.

Goods & Products	Services
▪ Lumber	▪ Soil protection
▪ Fuel	▪ Carbon storage
▪ Clothes	▪ Food, fruits & dietary diversity
▪ Shelter	▪ Habitat
▪ Food, fruit,	▪ Forest farming
▪ Dyes	▪ Create oxygen
▪ Glue	▪ Canopy lessens impacts of rainfall
▪ Rubber	▪ Provide organic matter for soils
▪ Gum	▪ Windbreaks
▪ Weapons	▪ Recreational services
▪ Tools	▪ Water capture
▪ Utensils	▪ Shoreline protection
▪ Bridges	▪ Minimize erosion

Goods & Products	Services
▪ Paper ▪ Furniture ▪ Industrial equipment ▪ Charcoal ▪ Medicine ▪ Crafts ▪ Drinks ▪ Jewellery ▪ Cosmetics and hair products ▪ Mulch ▪ Oils ▪ Insecticides	▪ Provide shading for other crops

Activity 4: Solutions - Fruit

As a final step, farmers will now identify agroforestry solutions to combat all of the negative effects they are seeing in the crops and fields. Many of the major modules of Agroforestry Farmer Field School should recent threats. This can be facilitated a variety of ways depending on the group. Small should arise as a result of this exercise. Give small groups sufficient time to each create through or four solutions and write or draw them on a bright coloured piece of paper.

- How can trees minimize wind damage to fields?
- What useful products do trees provide?
- 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?
- What do tree roots do to the soil?
- Are certain trees better for soil than others?
- What is a leguminous tree?

Conclusion

- We just defined **agroforestry** and **climate change** for our local context.

- Now I, the facilitator, have a better idea of some of the technical topics that our field school will want to investigate over the course of the next couple months.

- **Agroforestry ensures food security** by generating direct benefits to farmers such as food, fodder, feed for fish and livestock, fuel wood, live fences, and other products. The diversity of crops provides multiple harvests at different times of the year, thereby reducing the risk of crop loss and food shortage.

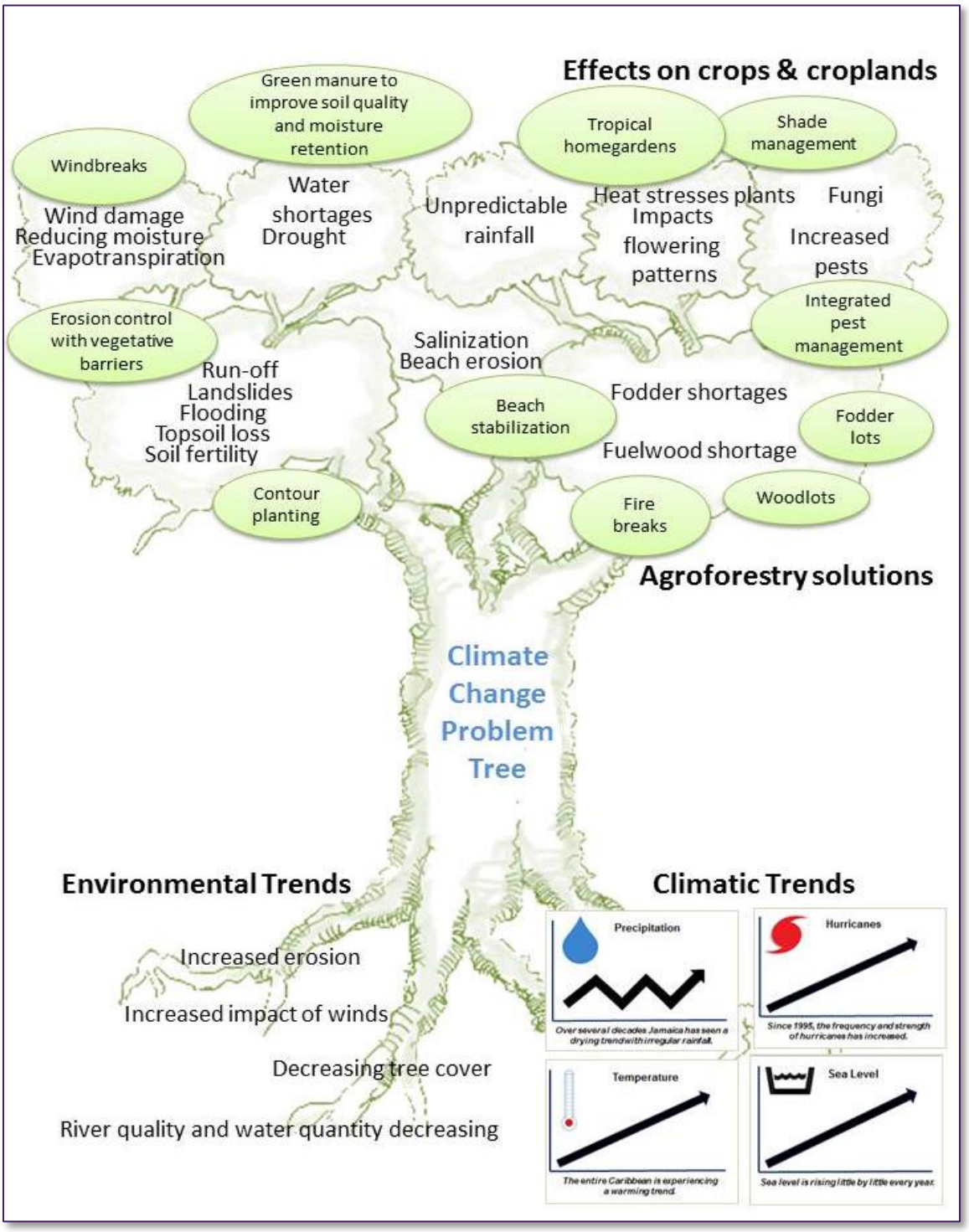
- **Agroforestry helps maintain ecological balance** by providing indirect benefits such as soil and water conservation, improved soil fertility, and improved microclimate conditions.

- **Agroforestry improves quality of life of farmers** by increasing income due to multiple harvests and sale of products from the systems' different components, thereby providing regular income throughout the year.

Handouts

Handout 1: Example of Completed Problem Tree
Handout 2: Form and Graphics for Environmental and Climatic Trends Exercise
Handout 3: Recent Trends, Projections, and Future Scenarios
Handout 4: Weather vs. Climate
Handout 5: Expected Impacts for Jamaica's Agricultural and Food Security
Handout 6: Greenhouse Gases (GHGs)
Handout 7: Common Terminology
Handout 8: Drivers of Vulnerability

HANDOUT 1: Example of a Completed Problem Tree



HANDOUT 2: Form and Graphics for Environmental and Climatic Trends Exercise

Then

Now

Storms/Hurricanes

Temperatures

Rains

Winds

Forests

Rivers

Soil

Fish

Fire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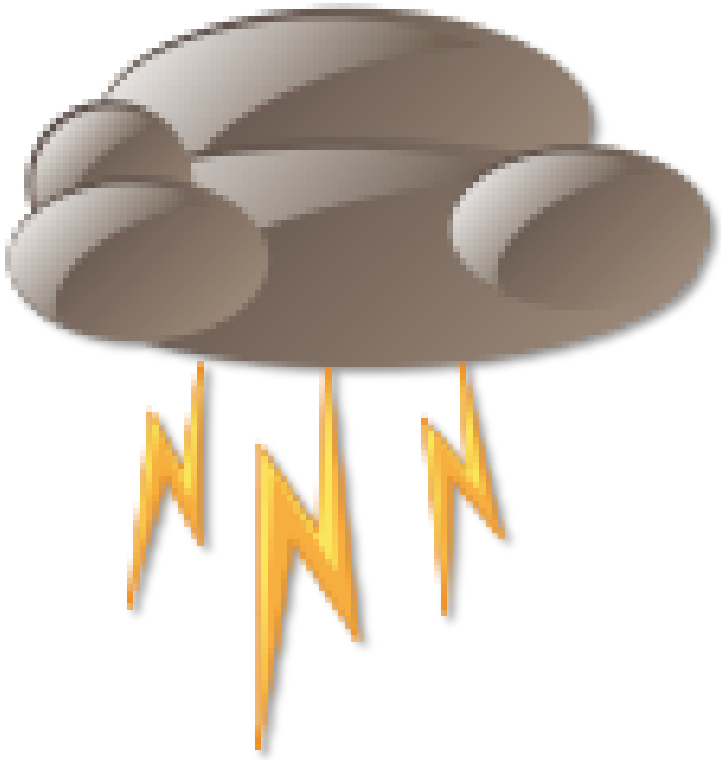

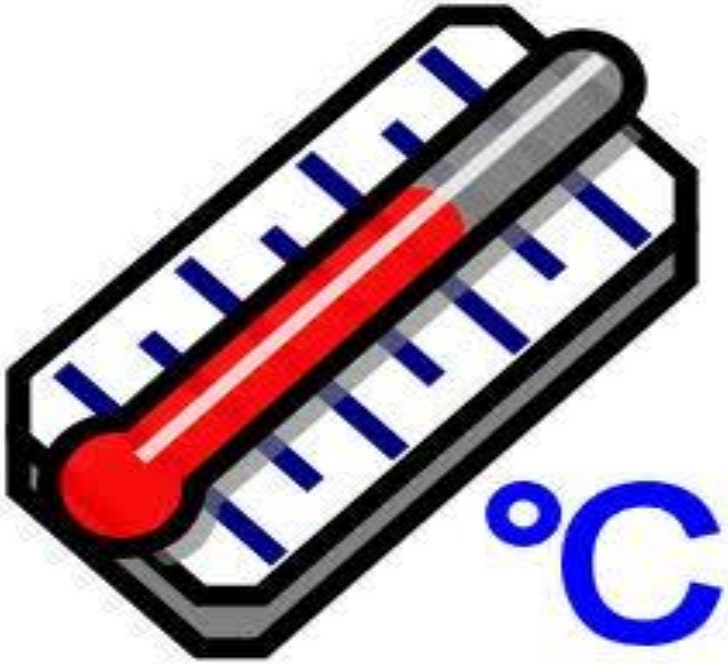
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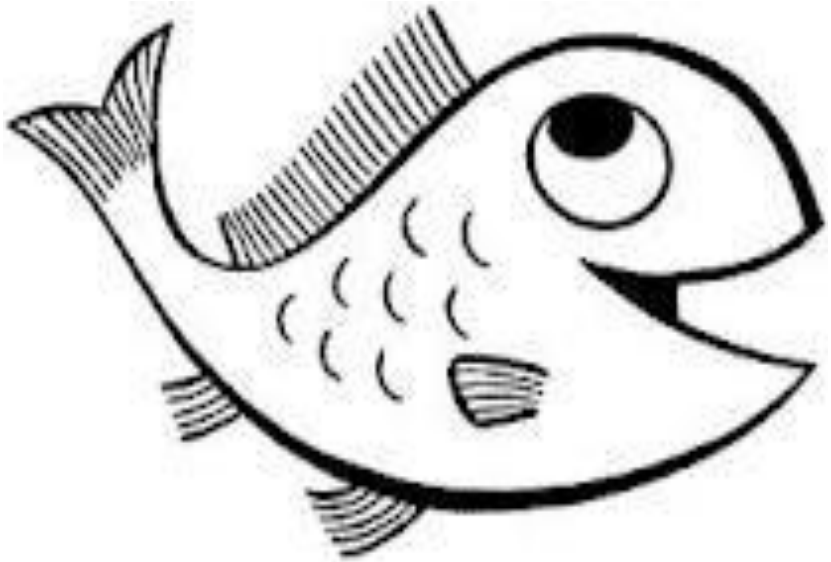
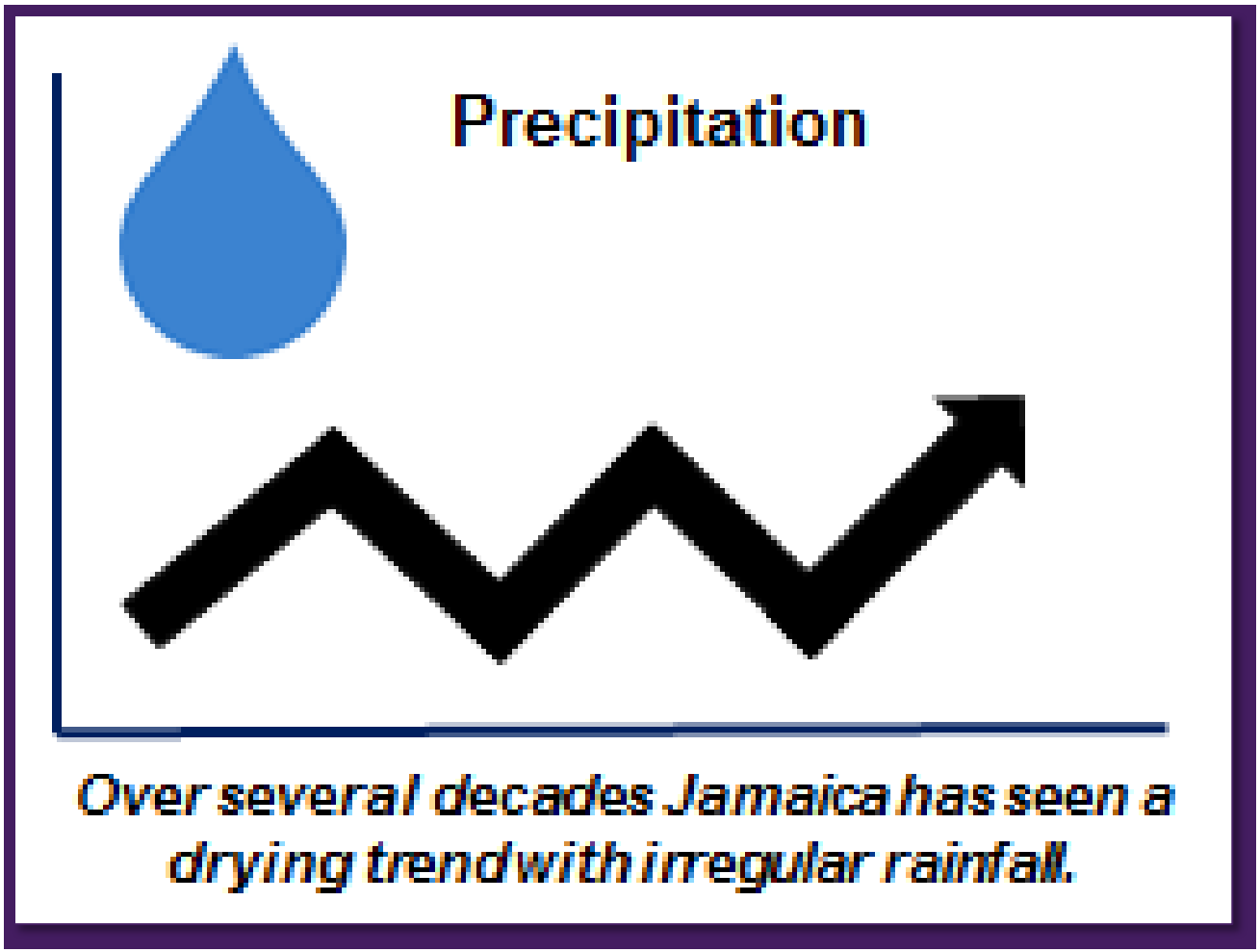
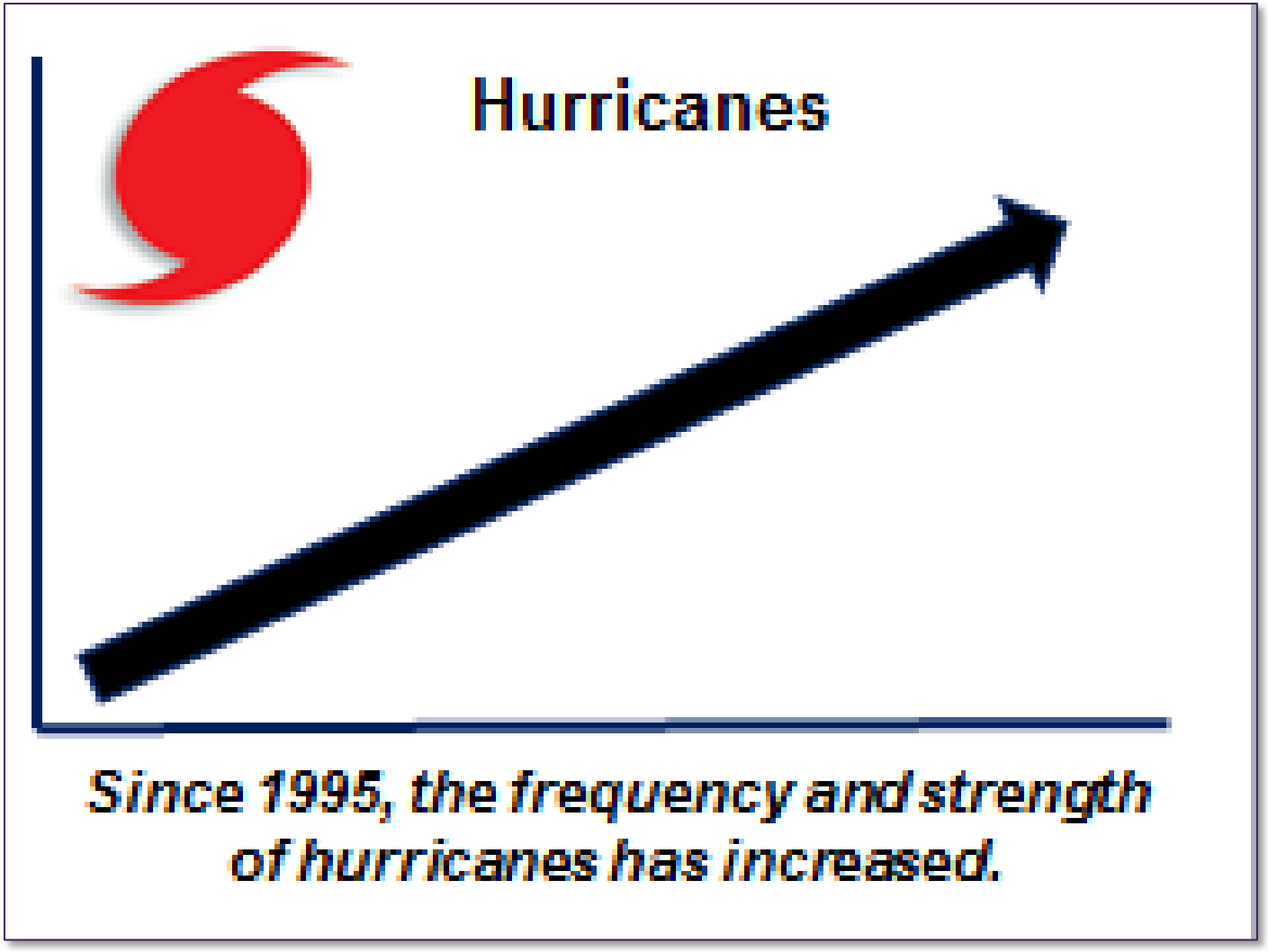
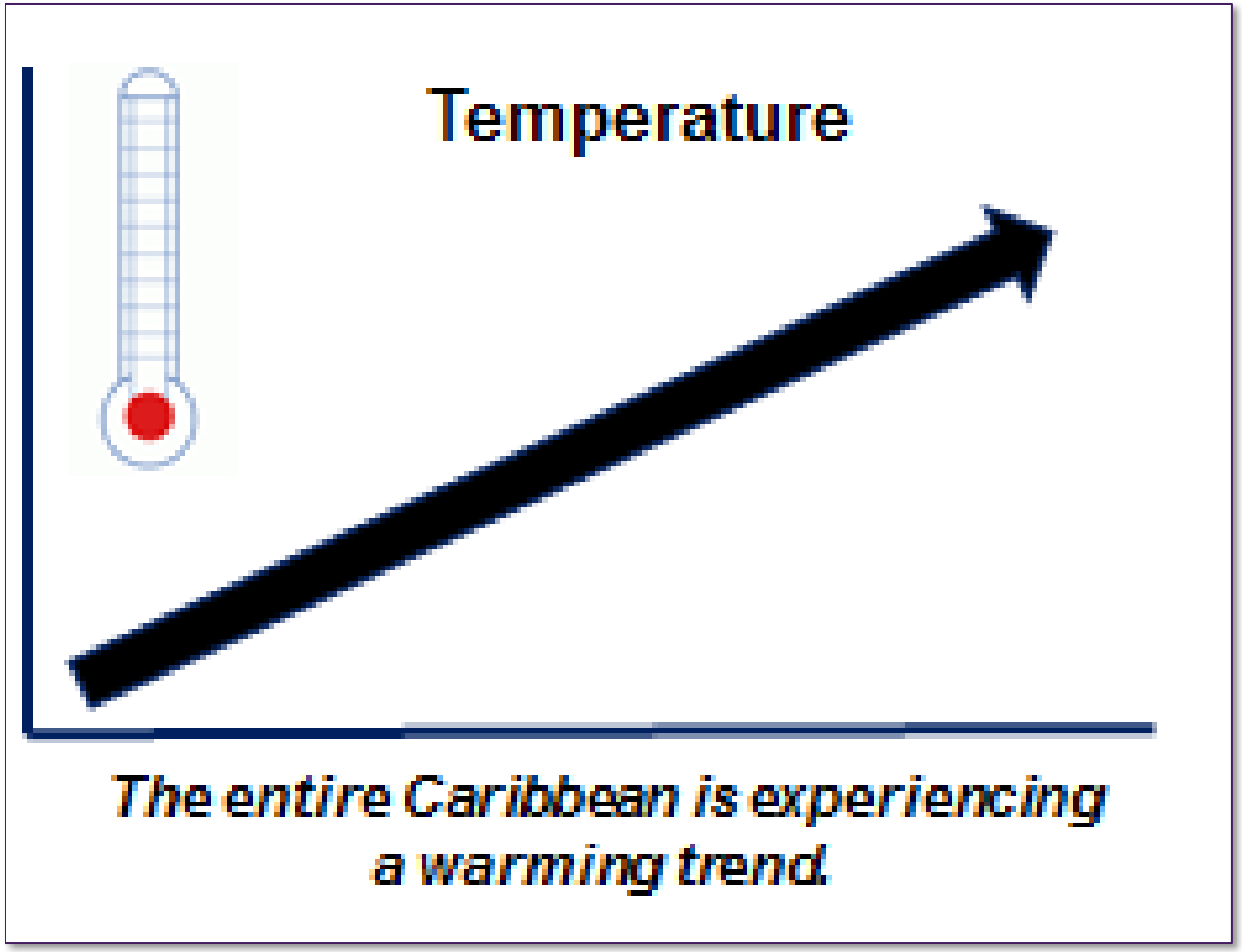
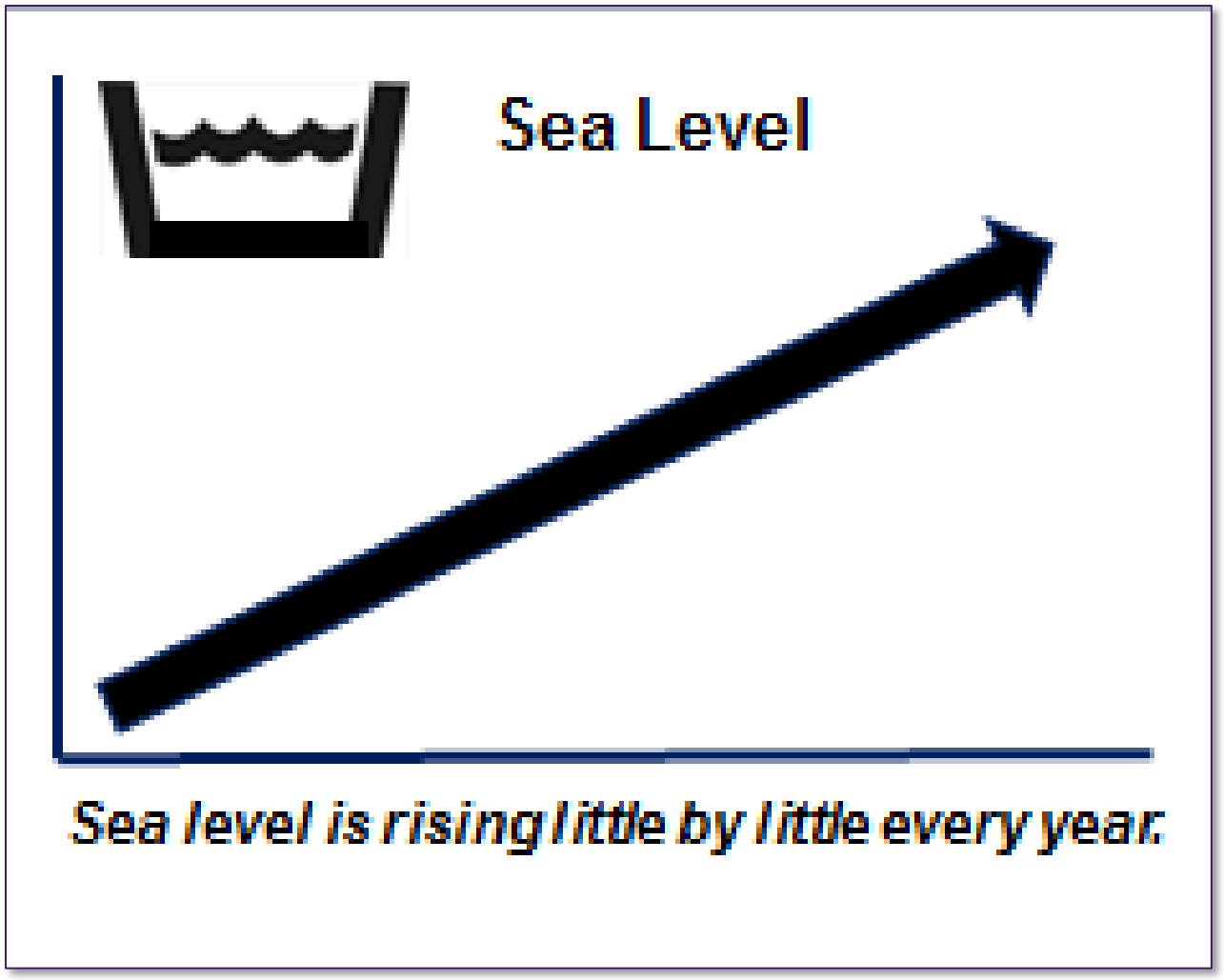



Precipitation
Over several decades Jamaica has seen a drying trend with irregular rainfall.


Hurricanes
Since 1995, the frequency and strength of hurricanes has increased.


Temperature
The entire Caribbean is experiencing a warming trend.

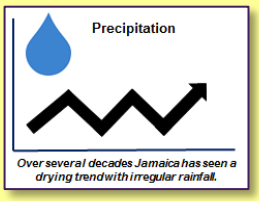
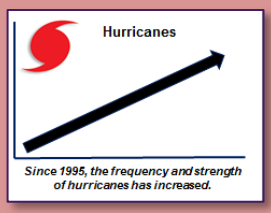
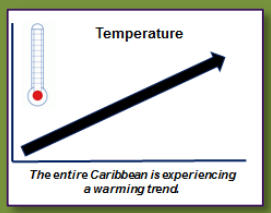
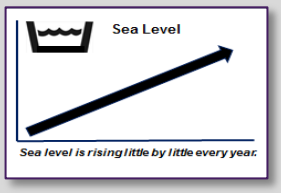

Sea Level
Sea level is rising little by little every year.

HANDOUT 3: Recent Trends, Projections, and Future Scenarios

Farmers state their observations confirm the data trends:

Explain the four recent weather trends in the Caribbean and Jamaica that affect agriculture production. After explaining the trend, ask the farmers the following discussion questions to solicit reactions.

- *Have you noticed these trends?*
- *Have you noticed something different in your area?*

Column 1: Climate Trends that have affected farmers	**Column 2**: What was the **EFFECT** on farmers' crops?
Changes in the timing and intensity of rainfall 	1. Drought 2. Flooding 3. Topsoil loss/Landslides 4. Unpredictable rainfall 5. Increased Pest/disease incidence
Hurricanes/Tropical Storm: more frequent and intense 	1. Flooding 2. Wind damage to crops and farm infrastructure 3. Topsoil loss /Landslides 4. Increased Pest/disease incidence
Changes in Temperature 	1. Increased water loss 2. New and increased pest and diseases 3. More stress on plants-defoliation 4. Impact flowering patterns- decrease in yields due to low maturity rate
Sea Level Rise 	1. Loss of coastal agricultural lands 2. Salinization of coastal agricultural lands with saline intrusion

Recent & Future Scenarios for Jamaica

- **Temperature**

Climate data records over the past 30-50 years document a general warming trend in the Caribbean, with Jamaica experiencing some of the most extreme climate variability in the region. Annual mean temperature changes for Jamaica, simulated by Regional Climate Models (RCMs), indicate increases of 2.9 to 3.4˚C by the 2080s

- **Precipitation**

Precipitation patterns in Jamaica over the past several decades have shown an overall drying trend through the summer months, with rainfall becoming more irregular in its distribution. Rains are being punctuated by periods of greater intensity and flash flooding, followed by longer dry spells, all concentrated within a shorter time span. *Thus, greater extremes of moisture and dryness are contributing to more severe soil erosion and exposure to pest infestation and plant disease*[2]. According to several models, an overall decrease (by 10 - 41%) in annual rainfall for Jamaica as a whole, particularly throughout March, April, May and June, July and August While a general drying trend will occur, rains will continue to fall with greater intensity when they do occur, and overall, relative humidity will rise.

- **Hurricanes**

The occurrence of tropical storms and cyclones in the Caribbean and North Atlantic Basin has risen sharply since 1995, with a doubling of category 4 and 5 hurricanes. There has been a marked increase in hurricanes affecting Jamaica since 2004, and six storms events between 2002 and 2010 resulting in $74 billion in losses to the Jamaican economy (USAID/USDA 2011). Observed and projected increases in Sea surface temperatures indicate potential for continuing increases in hurricane activity and model projections indicate that this may occur through increases in intensity of events but not necessarily through increases in frequency of storms.

HANDOUT 4: Weather vs. Climate

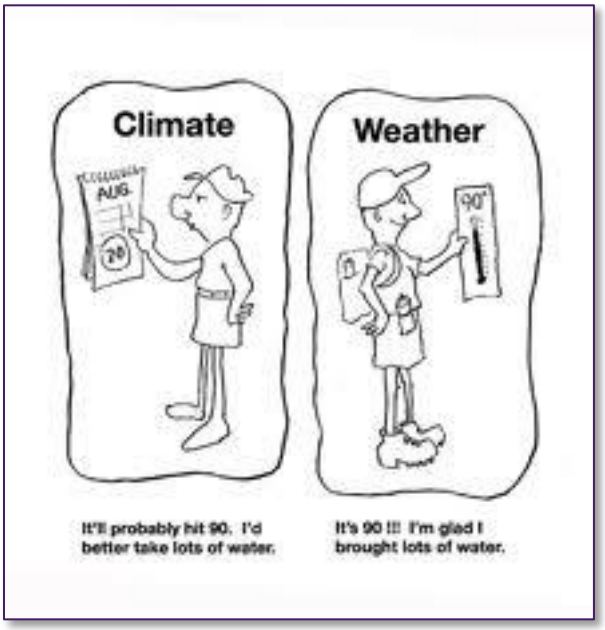
In order to define 'climate' it is important to distinguish it from 'weather'. The weather that we experience on a day-to-day basis is a momentary atmospheric state characterized by temperature, precipitation, wind, and so on, and seems to vary in an irregular way, not following any particular pattern.

When one considers longer time scales, weather can be seen to vary in a recurrent way, be it on global, regional or local scale. This is what we refer to as climate. In contrast to the instantaneous conditions described by weather, climate is described with average values (e.g. annual average, or mean, temperature), but also typical variability (e.g. seasonal maximum/minimum temperatures) and frequency of extremes such as monsoons/hurricanes/cyclones. The timescale upon which climate statistics are calculated is typically thirty years (e.g. 1981–2010).

"***Climate is what you expect, weather is what you get"***

WEATHER describes atmospheric conditions at a particular place in terms of air temperature, pressure, humidity, wind speed, and precipitation.

CLIMATE is often defined as the weather averaged over time (typically, 30 years).



HANDOUT 5: Expected Impacts for Jamaica's Agricultural and Food Security

Table 8.5.1: Impacts of Climate Change on Agriculture and Food Security.

	Climate Change Variables /Extreme Events	Impacts
AGRICULTURE & FOOD SECURITY	Increased Temperature	Citrus and root crops are affected by changes in temperature and precipitation (7,p.18). Rising temperatures are expected to result in reduced yield and growth of weeds, pests, bacteria and diseases (5,p.26).
	Decreased precipitation	Drought conditions affect agro biodiversity. Droughts also lead to large scale losses of cattle and lower reproduction rates among livestock (5,p.26). Threatens local agriculture, which demands 75% of local water supply (3,p. 29). Soil degradation and loss of fertility due to droughts (3,p.34). With projected decreases in precipitation up to 40% and up to 2.8 degree Celsius rise in temperature expected by 2080s, many domestic crops will be under stress and food security will be threatened (2,p.262). Higher water and production costs for local food production (6,p.19). Malnutrition resulting from disturbances in food distribution and production could also occur (3,p.34).
	Sea level Rise	Sea level intrusion in coastal agricultural areas and salinisation of water supply (5,p.27) In Jamaica, some wells have been abandoned due to increased salinity and others produce water unsuitable for agricultural use (4,p.74).
	Storms, Hurricanes and Floods	Passage of extreme events incurs losses of agricultural assets, livestock, crops and agricultural infrastructure (2, p.264). Especially severe for standing export crops (like banana, sugar cane, coffee) (2,p.265). Increased flooding will lead to inundation of production fields.(5,p.27)Increased precipitation and flooding also leads to more favourable conditions for crop disease (3,p.34). Increased food costs, increased costs of insurance and higher rates for capital cost loans (10, p.6). Threatens livelihoods as agriculture employs 25% of Jamaica's population (3,p.34).
	Rainfall patterns	Unreliable/Unpredictable rainfall patterns would affect product distribution ,quantity and quality (3,p.34).
	Additional information: Agriculture is one of the Jamaica's key economic sectors, in 2000 it contributed approximately 7.3% of the island's gross domestic product (GDP), and represented approximately 12% of foreign earnings (3,p.34).	

HANDOUT 6: Greenhouse Gases (GHGs)

What are the greenhouse gases?

Water Vapour is the most common greenhouse gas. But others that are very important too. Some occur naturally and some come from human activity.

Carbon Dioxide or CO2 is the most significant greenhouse gas released by human activities, mostly through the burning of fossil fuels. It is the main contributor to climate change.

Methane is produced when vegetation is burned, digested or rotted with no oxygen present. Garbage dumps, rice paddies, and grazing cows and other livestock release lots of methane

Nitrous Oxide can be found naturally in the environment but human activities are increasing the amounts. Nitrous oxide is released when chemical fertilizers and manure are used in agriculture.

Halocarbons are a family of chemicals that include CFCs (which also damage the ozone layer), and other human-made chemicals that contain chlorine and fluorine.

Most greenhouse gases are extremely effective at absorbing heat escaping from the earth and keeping it trapped. In other words, it takes only small amounts of these gases to significantly change the properties of the atmosphere. 99% of the dry atmosphere consists of nitrogen and oxygen, which are relatively transparent to sunlight and infrared energy, and have little effect on the flow of sunlight and heat energy through the air. By comparison, the atmospheric greenhouse gases that cause the earth's natural greenhouse effect total less than 1% of the atmosphere. But that tiny amount increases the earth's average surface temperature from -19°C to +14°C - a difference of about 33°C. A little bit of greenhouse gas goes a long way. Because the concentration of greenhouse gases in the atmosphere is so low, human emissions can have a significant effect. For example, human emissions of carbon dioxide (CO2) currently amount to roughly 28 billion tonnes per year. Over the next century human emissions will increase the concentration of carbon dioxide in the atmosphere from about 0.03% today to almost certainly 0.06% (a doubling), and possibly to 0.09% (a tripling).

HANDOUT 7: (GHGs) Common Terminology

Weather describes atmospheric conditions at a particular place in terms of air temperature, pressure, humidity, wind speed, and precipitation.

Climate is often defined as the weather averaged over time (typically, 30 years).

Climate Variability refers to variations in the mean state of climate on all temporal and spatial scales beyond that of individual weather events.

Examples of climate variability include extended droughts, floods, and conditions that result from periodic El Niño and La Niña events.

Climate Change refers to shifts in the mean state of the climate or in its variability, persisting for an extended period (decades or longer). Climate change may be due to natural changes or to persistent anthropogenic changes in the composition of the atmosphere or in land use.

Greenhouse Effect is "a general warming effect" felt on Earth's surface, produced by greenhouse gases.

Vulnerability to the impacts of climate change is a function of exposure to climate conditions, sensitivity to those conditions, and the capacity to adapt to the changes.

Vulnerability is determined by exposure, sensitivity, and adaptive capacity

- **Exposure:** Is an asset/input faced by climate stress? Where? When?
  - ✓ Flooding, drought, erosion, sedimentation; and
  - ✓ Agriculture is exposed, highly dependent on weather/climate.
- **Sensitivity:** Does exposure matter? How susceptible is an asset to harm?
  - ✓ Are crops suitable to a range of temperatures and precipitation profiles?
- **Adaptive Capacity:** Can people respond to the stress to reduce harm?
  - ✓ Irrigation, improved drainage, adjusted crop selection;
  - ✓ Crop and economic diversification can reduce damages; and
  - ✓ Insurance spreads risk.

- Exposure to climate variability and change which refers to the degree of climate variability and change that an entity (a country, community, individual or ecosystem) experiences;
- Sensitivity to climate shocks and stresses, which is an assessment of the amount of impact climate factors have on the entity; and,
- Adaptive capacity, which describes the ability of the entity to manage the negative impacts and take advantage of any opportunities that arise

Climate Adaptation refers to adjustment in natural or human systems moderate, cope with, or take advantage of actual or expected changes in climate conditions. Various

types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

Climate Mitigation is any action taken to permanently eliminate or reduce the long-term risk and hazards of climate change to human life, property. It is any anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.

Definitions are based on IPCC Climate Change 2001 and 2007 Impacts, Adaptation and Vulnerability reports as well as OECD's report, "Bridge Over Troubled Waters"

HANDOUT 8: Drivers of Vulnerability

V=E x S - AC

Climate change will affect different groups to differing degrees and in different ways. Factors that influence differences in vulnerability:

- Overall vulnerability – Gender, age, ethnicity, disability;
- Exposure – Occupation, location;
- Sensitivity – Skills, health status; and
- Adaptive Capacity – Information, resources, support networks.

What makes us vulnerable?

- Insufficient knowledge of GCC and options for adaptation
- Location,
- Socio-economic barriers(poverty, gender, age)
- Inadequate access to technical expertise to implement adaptation options
- Weak legislative/policy frameworks to support action

To assess the level of impact hazards may have on each exposure unit you can agree on different categories. For example, you could use a scale of 1-3, 3=high impact; 2=medium impact; 1=low impact, O= no impact, N/A= non-applicable

Table 4: Example of a Table for Vulnerability-Exposure Matrix

	Droughts	Floods	Sea-level rise	Strong winds	Dryspells	Intense rainfall
Key resources						
Forest						
cash						
Agricultural skills						
religions associations						
road network						

Module 3: Agroforestry Ecosystem Analysis for Agroforestry

Objectives

- To improve farmers' knowledge and skills in identifying the morphological characteristics at different growth stages of agroforestry tree species and vegetable crops.
- To understand minimum data necessary for decision-making in the AFESA process.
- To help farmers improve their observational, analytical and decision-making skills and apply same to the agroforestry setting.
- For farmers to be able to carry out regular inspections of their farms to anticipate, determine and treat with threats and problems that may occur in their fields.
- To familiarize farmers with the most common forestry, fruit tree and vegetable crops species in an AFESA learning plot and or adjoining fields.

Venue

Demoplot and or adjoining fields of agroforestry species and vegetable crops near each other where morphological characteristics at different growth stages can be observed

Materials

- Flip chart paper
- Notebooks
- Markers
- Pencils
- Crayons
- Pens
- Plant specimen (live plants or plant parts)
- A Horizontal surface
- Razor blades
- Cardboard with white background
- Pins
- Hand lens
- Tape measure
- Transparent plastic bags
- Flipchart stand

ACTIVITIES

Activity 1: First AFESA **(2 hours)**

NOTE

When this is exercise most appropriate?

- Before conducting field activities in an AFFS for mixed crops.
- At each AFFS session in a season-long AFFS training activity.
- When farmers are introduced to their first technical FFS training session.
- When farmers need to capture data that will help to guide crop/farm management decisions.
- When farmers need to understand the level of pest infestation in an area where they plan to carry out agroforestry activities

- First AFESA - Introduce farmers to the concept of AFESA. Discuss the reasons for doing AFESA on a regular basis and have them discuss the advantages and disadvantages of AFESA. **(30 minutes)**

- Farmers in their smaller groups (approximately five to six persons per group) are guided through the field walk noting all the significant features in and around it. **(30 minutes)**

- Draw the field on a blank sheet of paper - preferably flip chart paper - with markers and map everything within 100 meters of the field on all sides. **(30 minutes)**

  ✓ Observe and capture as much as possible in the maps concerning the various features in and around the field.

  ✓ Encourage farmers to ask themselves - while carrying out the mapping exercise - the following questions to help identify some of the major factors that could affect your production in the field.

REFERENCE

- Is there a slope to the field?
- What is growing around the field?
- Which direction does the wind blow?
- What is located in the demoplot?
- What other significant features are located in the demoplot?
- Is the soil uniform throughout the field?
- Does soil type vary throughout the field?
- Whose farms are nearby?
- What are the neighbours planting and growing in their fields?
- What was grown in the field last year?
- What insects are present? Where?
- Where are the access areas?
- What kind of other activities are done in neighbouring area?
- Is there a road or path?
- Where is the water source, if any?
- What are the threats to the field?
- Do you see any variation in the colour of the soil throughout the field?

- The farmers in their small groups discuss, analyze and draw conclusions as to minimum data necessary for decision making along with recommendations to reduce threats to the agroforestry plot. **(30 minutes)**

- The large group of farmers is assembled and the individual groups report out on their findings and recommendations after which the ***final data requirements*** are agreed for each group of agroforestry species and vegetable crops. ***(AFESA form – Hand-out 3)***

- Recommend actions to be taken in and around the demoplot to reduce threats are also agreed along with a work plan for execution.

Activity 2: Second AFESA **(2 hours)**

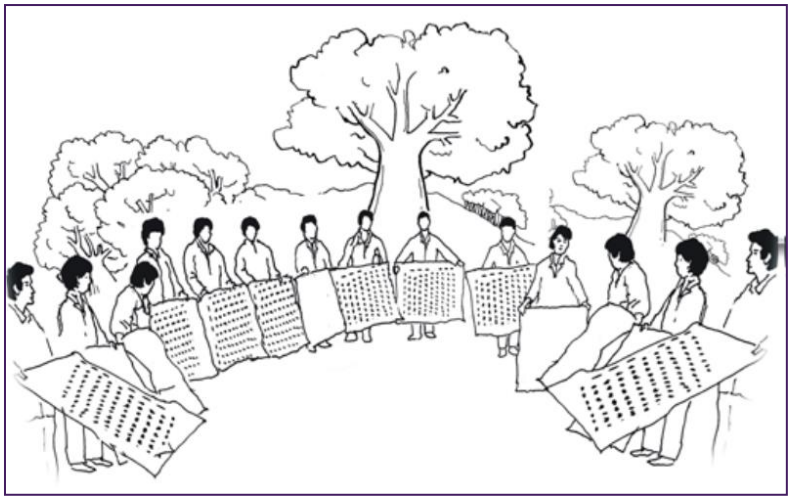
- Recurring AFESA - Farmers go through the review process of what they did at the initial AFESA if required. **(15 minutes)**

- If not done prior, farmers must draw the field outline on a blank sheet of paper with markers and insert the major features in and around the field. The facilitator shall discuss with the group to determine an effective way to walk the field and check plants in such a manner that the results would be representative of the entire plot. **(10 minutes)**

- Observe and capture as much as possible in the map concerning new features and or observations in and around the field since the previous AFESA. **(10 minutes)**

(50 minutes)

Introduce the concept of data recording and AFESA forms – modified by minimum data requirement decided on by the group coming out of the initial AFESA - to farmers and discuss in detail how it is properly completed making sure that the focus remains on how the capture of data for decision making can affect farming income positively.



- Continue in this discussion with the farmers to focus on the ways that they stand to benefit their farm operations by consistently recording data.

- Divide the larger group into smaller groups of approximately five to six persons.

- Assign each small group to a specific section of the demoplot or learning field

- Conduct field walks to identify, observe, and record morphological characteristics of commonest plant/forestry species in AFFS demoplot/learning field such as:

  ✓ Adaptability to local conditions;
  ✓ Morphological structures at various growth stages;
  ✓ Resistance to pests and diseases; and
  ✓ Tolerance to deficiencies, toxicities, and other environmental stresses.

- Collect plants or plant parts at various growth stages showing morphological characteristics and reactions to pests, diseases, and environmental stressors

- Go back to processing area to further observe and characterize collected specimen

(35 Minutes)

- Engage the farmers' group in a brainstorming discussion to analyze and draw conclusions as to actions required to reduce threats to the agroforestry plot. Present output of small groups to the big group and conduct participatory discussions to fine tune established minimum data necessary for decision-making in farmer field schools for each group of agroforestry species and vegetable crops.

- The farmers in their small groups discuss, analyze and draw conclusions from their observations and make recommendations to reduce threats to the agroforestry plot.

- The large group of farmers is assembled and the individual groups report out on their findings. Recommendations as to actions to be taken in and around the demoplot to reduce threats are also agreed along with a work plan for execution.

NOTE

The following AFESA exercises will be conducted at the beginning of each AFFS session and will last approximately 30 minutes the remainder of the AFFS session will be dedicated to the presentation of the scheduled AFFS module.

Daily Observation and Analysis

The facilitator will facilitate the discussion by asking guiding questions and makes sure that all participants (also shy or illiterate persons) are actively involved in this process.

- Summarize the present situation of the field?

- What aspect is most important at this moment?

- Is there a big change from last week? What kind of change?
- Is there any serious pest or disease outbreak?
- What is the situation of the beneficial insects?
- Is there a balance in the field between pests and defenders?
- Were you able to identify all pests and diseases?
- Do you think the crop is healthy?
- What management practices are needed at this moment?
- When will it be done? Who will do it? Make sure that responsibilities for all activities are being discussed.
- Are you expecting any problems to emerge during the coming week? What problems? How can we avoid it? How can we be prepared?
- Summarize the actions to be taken.

Handouts

Facilitator's Resource

Handout 1: How to Conduct an AFESA
Handout 2: AFESA Form

HANDOUT: Facilitator's Resource

Introduction

Agroforestry ecosystem analysis (AFESA) is a way of assembling what farmers are studying and placing it into a process useful for decision making based on many factors. An AFESA, therefore, must look into various elements of an agroforestry crop ecosystem, how these elements, in one way or another, affect a crop and what are those elements that work interdependently or separately for a particular agroforestry species and vegetable crops.

The process entails small groups of participants collecting data from field studies, discussing the findings, and arriving at a consensus for crop management using the information as the basis for field management decisions. Discussions on observations and "what if" scenarios within and between small groups as well as in a bigger group of field school participants encourage critical thinking skills. The process of working in groups fosters team building and is valuable for establishing farmers groups that will continue to work together beyond the field school. The goal of agroforestry ecosystem analysis is to develop skills in crop ecology observations and assessment which will assist farmers to make intelligent and sound crop management decisions.

AFESA Process Matrix

Activity	Critical Steps	Notes	Indicators
AFESA Primary FFS activity ▪ **Observation** ▪ **Analysis** ▪ **Decision making Farmers become experts**	Observation & Drawing of Agro ecosystem	Participants need to understand the process of observation and its purpose or objective. Participants in field observing, taking notes, collecting specimens. Purpose of drawing is to summarize observation, focus of analysis.	1. Before activity participant told a. Goal of activity and b. Process to be followed in activity 2. Participants all in the field 3. Process of observation includes the whole plant 4. Observation written down 5. Specimen collected 6. Drawing summarizes observations
	Presentation & Analysis	Presented to large group by one member of each small group. Problems posed, questions asked. Purpose: to discuss field conditions & solve "what if" scenarios. Objective: to improve decision making &	1. Presentation made by member of each small group 2. Participants ask presenter questions 3. Facilitator asks questions appropriate to analysis 4. Group discusses field conditions & agro ecosystem

Activity	Critical Steps	Notes	Indicators
		analytical skills based on ecosystem observation. Facilitator helps group achieve objective by asking probing questions to help analytical process	relationships 5. “What if” scenarios discussed 6. Previous weeks’ agro ecosystem drawing used for comparisons 7. Field management decisions critically examined by group 8. Other factors in addition to economic thresholds are analyzed e.g. Plant stage, natural enemies 9. Facilitator uses leading questions to help participants analyze what was learned during activity

HANDOUT 1: How to Conduct an AFESA

HOW TO CARRY OUT Agroforestry Ecosystem Analysis (AFESA)

There are three major stages to conducting the AFESA: **OBSERVATION, ANALYSIS AND DECISION.**

Observation

Go to the demo-plot in small groups. Walk across the field and choose 20 plants randomly. Observe keenly each of these plants and record your observations on the scouting form:

- Overstory: observe the shade canopy and all activity (seeding, fruiting) occurring
- Understory: observe the small trees, bushes and fruit trees
- Plants: observe the plant height, number of leaves, crop stage, deficiency symptoms
- Pests: observe and count pests at different places on the plant.
- Defenders: (natural enemies): observe and count parasitoids and predators.
- Diseases: observe leaves and stems and identify any visible disease symptoms.
- Weeds: observe weeds in the field and their intensity.
- Water: observe the water situation of the field.
- Weather: observe the weather condition.

Analysis

While walking in the field, manually collect insects in plastic bags. Collect plant parts with disease symptoms. The facilitator will lead the discussion by asking guiding questions and make sure that all farmers (also shy or illiterate persons) are actively involved in this process.

- The groups will talk about the crop situation. The facilitator will ask questions to initiate the discussion and to stimulate critical thinking.
- Find a shady place to sit as a group in a small circle for drawing and discussion.
- Each group will first identify the pests, defenders and diseases collected.
- Each group will then analyze the field situation in detail and present their observations and analysis in a drawing (the AFESA drawing). The drawing is essentially one composite sketch that includes the group's entire finding on the plants they observed.
- Each drawing will show a plant/hill representing the field situation. The weather condition, water level, disease symptoms, etc. will be shown in the drawing. Pest insects will be drawn on the left. Defenders (beneficial insects) will be drawn on the right. Write the number next to each insect. Indicate the plant part where the pests and defenders were found. Try to show the interaction between pests and defenders.
- Each group will discuss the situation and make a crop management recommendation.
- The small groups then join each other and a member of each group will now present their analysis in front of all farmers. A different person will present each week.
- Keep the drawing for comparison in the following weeks.
- Summarize the present situation of the field.
  - ✓ What aspect is most important at this moment?
  - ✓ Is there a big change from last week? What kind of change?
  - ✓ Is there any serious pest or disease outbreak?
  - ✓ What is the situation of the beneficial insects?
  - ✓ Is there a balance in the field between pests and defenders?
  - ✓ Were you able to identify all pests and diseases?
  - ✓ Do you think the crop is healthy?
- What management practices are needed at this moment?
- When will it be done? Who will do it? Make sure that responsibilities for all activities are being discussed.
- Are you expecting any problems to emerge during the coming week? What problems? How can we avoid it? How can we be prepared?

Decision

- *Formulate a common conclusion.*
- *The whole group should support the decision on what field management is required Make sure that the required activities (based on the decision) will be carried out.*

HANDOUT 2: AFESA Form

AGROFORESTRY ECOSYSTEM ANALYSIS FORM - SECOND DRAFT						
AFESA Week #:	**Time Started:**		**Time Ended:**		**Date:**	
PERSONAL INFORMATION						
Farmer Name:		**Location:**				
Gender:	**Land Tenure:**		**GPS:**	**RADA Registration #:**		
GENERAL INFORMATION						
Size of holding (Hectares):	**Area under active production (Hectares):**			**Soil type:**		
Temperature (Celsius):	**Terrain description:**				**Irrigation (y/n):**	
Soil condition	Wet	Moist	Loose	Light crust	**INNOVATION OPPORTUNITIES (tick)**	
Weather condition	Sunny	Partly sunny	Calm	Light wind	**Line planting**	
Major topography/slope type	> 45 %	< 45 %	rolling	flat	**Spot filling**	
Accessibility of field	very good	good	satisfactory	poor	**Wind break**	
Ease of movement through the field	very good	good	satisfactory	poor	**Riparian strip**	
Drainage	very good	good	satisfactory	poor	**Home garden**	
Nutrition status of the field	very good	good	satisfactory	poor	**Multi-story Prod.**	
Shade canopy management	very good	good	satisfactory	poor	**Taungya system**	
Land husbandry practises	very good	good	satisfactory	poor		
FARM PRODUCTION INFORMATION						
MAJOR TIMBER SPECIE (max. 6)						
Planting pattern and spacing						
Stage of production						
- seedling						
- sapling						
- juvenile						
- mature						
Average height/diameter						
MAJOR FRUIT TREE SPECIE (max. 6)						
Planting pattern and spacing						
Stage of production						
- seedling						
- sapling						
- juvenile						
- mature/production						
Average height/diameter						
MAJOR VEGETABLE SPECIE						
Planting pattern and spacing						
Stage of production						
- seedling						
- rapid vegetative growth						
- flowering/fruit development						
- mature/production						
Average height/diameter						
BENEFICIALS AND PESTS						
Beneficial animals observed						
Incidence - beneficial animals	very high	high	moderate	low	very low	
Diseases / disease symptoms observed						
Incidence - disease	very high	high	moderate	low	very low	
Insect pests observed						
Incidence - insect pests	very high	high	moderate	low	very low	
MAJOR OBSERVATIONS			**RECOOMMENDATIONS / OPPORTUNITIES**			

Agroforestry Ecosystem Analysis

Farmer information

Name:

Cell phone:

RADA #:

Gender:

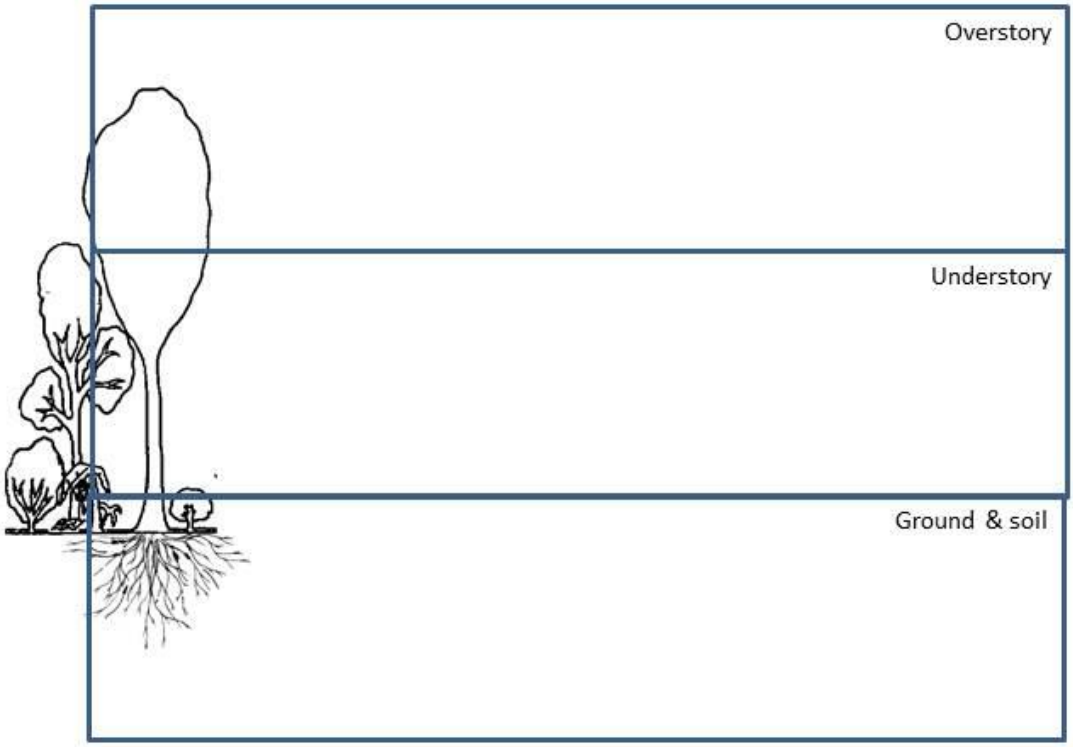
Location:

GPS:

Directions:

Mini map of field and/or nursery

Observations



Discussion notes

Plants
Trees
Pests
Defenders
Weeds
Water
Weather
Interactions
Drought
Flooding
Shading
Erosion
Wind
Soil quality
Threats
Livestock
Protection
Seedlings
Dampening off
Pruning

Recommendations

1.

2.

3.

4.

5.

Module 4: Agroforestry Farm Planning

Objectives

- To teach farmers the Agroforestry Farm Planning (AFP) methodology as a tool to design agroforestry innovations that optimize use trees, shrubs, palm trees and other woody perennials in the farm to achieve climate-smart and business-savvy objectives.
- To give farmers a tool for designing and prioritizing agroforestry interventions in their farm.
- To show why planning is important in developing agroforestry practices.

Supplies

- Forms (# 1 to # 10);
- Guide for diagnosing; and
- Measurement tape, local forest expert and AFP training manual.

Preparation

Before this meeting, work with the farmers to select a farm - preferably with different land uses and with line plantings in boundaries or in internal divisions - where the session can occur. It is important that the heads (man and woman) and other members of the farm family be present and participate in the session.

Venue

A farm with different land uses and some internal divisions

Total Time

6 hours

Summary

Agroforestry Farm Planning – The Diagnosis & Design (D&D) Process

Agroforestry Farm Planning consists of two phases: the **diagnosis** of the current situation and the **design** of new innovations.

Diagnosis

Assessing farm assets and livelihood strategies, identifying problems and opportunities.

Step 1: With the farmer, draw a map of the farm detailing all fields (crops, pastures, others), line plantings (farm boundaries, internal farm divisions, roads, water courses, living fences, windbreaks, hedges) and spots with special site conditions that influence the selection or management of crops and trees (areas with proper conditions for planting trees, or on the contrary, places with shallow, rocky or infertile soils, very steep slopes, exposure to strong winds, etc.).

Step 2: List all wood and non-wood products obtained from trees in the farm, current and desired.

Step 3: Describe the characteristics, goals and SWOT of both the family group and the farm.

Step 4: Inventory all trees in farm fields and line plantings (botanical composition, abundance by species), indicate yield (goods and services) per species.

Step 5: Analysis and manipulation of **interactions** in the agroforestry systems selected for recommendation to farmers.

Design

Search for opportunities to optimally use trees and other woody perennials in the farm. Criteria: higher yields, sustainability, adoptable without heavy external (donors or government) incentives.

Step 1: List, prioritize and select 1-2 innovations per farm.

Step 2: Fully describe (technical, financial, social aspects, analysis of interactions) selected innovations.

Step 3: Evaluate the adoption potential of selected innovations (criteria: superiority, compatibility, simplicity, feasibility, quick results).

Step 4: Plan and implement innovations in the farm.

Step 5: Evaluate the performance and impacts of innovations.

Activities

1. **Introduction to the Agroforestry Farm Planning (AFP)**: The facilitator asks the participants what is AFP? And how can we do it? Then, the answers must be corrected or complemented with the following as reference:

REFERENCE

The main purpose of agroforestry is to help farmers effectively manage the interactions between woody plants and the crops and animals on different plots of land on the farm. AFP allows producers to manage interactions in order to increase production, value and conservation on farm. AFP is applicable to farms of all sizes. AFP pays a lot of attention to the use and management of trees, shrubs, palms, vines and giant grasses like the bamboo on farm. AFP is done in two stages (D and D): 1) A diagnosis and 2) The search for solutions (design).

2. **Conducting AFP Diagnosis:** The diagnosis is divided into three parts: I. Biophysical, II. Agroforestry and III. Social and economic. The group must develop them together with the farm family. Several tasks must be accomplished to collect the necessary information for the diagnosis. That data will be the basis for the design phase. Using the formats given in the Forms and the detailed guides and explanations (in handouts), all the information must be written on big flip chart paper.

2a. *Assessing farm assets and livelihood strategies, identifying problems and opportunities*

Step 1: **Map the farm.** With the farmer, use Form #1, #2a and #2b to draw a map of the farm detailing all fields (crops, pastures, others), line plantings (farm boundaries, internal farm divisions, roads, water courses, living fences, windbreaks, hedges) and spots with special site conditions that influence the selection or management of crops and trees (areas with proper conditions for planting trees, or on the contrary, places with shallow, rocky or infertile soils, very steep slopes, exposure to strong winds, etc.).

- This is a key step which must be done with plenty of patience. The sketch should reflect all of the land uses on the farm, internal divisions, boundaries, and roads, as well as descriptions of slopes and streams. The length of the segments and parcels should also be noted.

Step 2: **Family structure and goals.** Detail the family structure using Form #3 and describe the characteristics, goals and SWOT of both the family group and the farm using Form # 8.

- It is important to know the composition of the family (members, ages, work in the farm) and also their objectives and future vision for the farm. This part of the diagnosis also includes assessing what goods (products) and services the family is already obtaining from the farm and which ones are desired. All of this information will be used as a foundation for suggesting solutions.

2b. Assessing Farm Inventories and Yields: It is time to walk through the farm to verify information that will be used in creating the farm map and to assess the agroforestry situation of the farm using the following five (5) agroforestry questions:

REFERENCE

- Where are the woody perennials located in the farm?
- Which species of woody perennials grow in the parcel or line?
- How many plants of each woody perennial species are there in the parcel or line?
- Which goods (products) or services does the farmer obtain from these woody plants in the parcel or line?
- Which favourable or unfavourable interactions do these woody perennials have with other crops or animals in the parcel or line?

Step 4: **Use Forms 5, 6, 7,** and **8** to make an inventory all trees in farm fields and line plantings (botanical composition, abundance by species). Remember to indicate yield (goods and services) per species.

Step 5: Analysis the situation of the family and farm.

- Using the information collected from steps 1 – 4 above conduct a SWOT (strengths, weakness, opportunities and threats) for the farm. This analysis will give more information for prioritizing and suggesting realistic solutions. Use Form 8.

NOTE

It is important that the facilitator stimulate the analysis of interactions in each land use of the farm, asking the farm family to identify both positive and negative interactions. In the case of negative interactions such as competitions for nutrients and water, brainstorm with the farmers how to improve those interactions. The discussion and analysis will be useful for the farm as it will stimulate thoughts on alternate solutions to solve different situations. This type of analysis will be used consistently throughout all the sessions of the Agroforestry Farmer Field Schools where specific agroforestry innovations will be explored.

3. **Preparing the Innovation Design:** search for opportunities to optimally use trees and other woody perennials in the farm. Criteria: higher yields, sustainability, adoptable without heavy external (donors or government) incentives.

Step 1: List, prioritize and select 1-2 innovations per farm.

- Divide the AFFS group into two or more subgroups.
- Instruct each group to propose one agroforestry innovation (design) to solve or to improve a given land use challenge of the farm.

Step 2: Use Form 9 to fully describe (technical, financial, social aspects, analysis of interactions) selected innovations.

NOTE

To decide which designs are best for the family and the farm, it is necessary to consider the economic feasibility of hiring workers, purchasing materials, and marketing products some products. It's also important to see if the proposed solution fits in with the farmer's plans and those of his family, taking into account their objectives (tastes and preferences).

Step 3: Evaluate each agroforestry innovations using the criteria and scoring explained in Form 11.

- Finally, the time to compare our final designs has come!!! The results will show us if we were able to suggest adequate solutions for the family.

  ✓ Instruct each group to present its proposed agroforestry innovations to the family and to the other participants. Some people should be

designated to play devil's advocate so that the pros and cons of both designs are fully discussed.

- ✓ Each agroforestry innovations will be evaluated by giving scores for the twenty attributes. The agroforestry innovation with the highest total score is recognized as the best to be implemented.

- ✓ The fact that one agroforestry innovation was qualified as the best, it does not necessarily mean that the other proposed agroforestry innovations are bad. They could be also implemented if the family wants.

- ✓ If the evaluation exercise did not produce a clear best choice, then consider using Agroforestry as a Business to explore in more detail the projected income of the various agroforestry options.

Step 4: Plan and implement innovations in the farm

- Now, the task for the family is to plan when to implement the suggested agroforestry innovations.

Daily Summary and Observation Analysis

Reconvene the farmers in a circle at the end of the session. Facilitate the daily summary by asking questions such as:

- What did you think about the work today?
- What was easy about today's activities?
- What was difficult in today's activities?
- What observations do you have?
- What are the advantages of working together?
- What costs are involved and how can we decrease costs?

REFERENCE FOR DISCUSSION

Agroforestry Farm Planning is a methodology that must be implemented methodically and with patience.

- More precise information about the farm, family and SWOT (diagnosis) will lead to better proposed agroforestry innovations (design)
- After having taken the time to design and evaluate the proposed agroforestry innovations, the group should be realistic about what family can do with their available resources.
- If the evaluation exercise did not produce a clear best choice, then consider using Agroforestry as a Business to explore in more detail the projected income of the various agroforestry options.

Handouts

Facilitator's Resource

Handout 1: Forms
Handout 2: Detailed Guide of the Steps of Agroforestry Farm Planning

HANDOUT: Facilitator's Resource

Farmers and other landowners drawing sustenance from the land strive continually to produce goods through methods that are economical, conservation-minded and socially acceptable. Agroforestry practices can provide many different environmental and production benefits for a farm and its surrounding area. However, it can be a complex task to determine what opportunities, limitations, and trade-offs exist in each situation. The goal is to design an agroforestry practice that achieves the best balance among them. Planning helps determine the best design before the landowner commits to planting something in the field. AFP increases the rate of success in agroforestry establishment.

Agroforestry Farm Planning is a methodology that helps farmers and technical staff to diagnose the status of the tree component of the farm and develop innovations that best respond to the goals and capacities of the farms and families. It is applicable to both small and large farms, whether they are family or commercial farms. The methodology combines the agroforestry D&D (Diagnosis and Design) methodology developed by ICRAF (Raintree 1987) with SWOT (strengths, weakness, opportunities and threats) analysis and various cropping system methodologies.

Key Definitions

- **Agroforestry** is the management of interactions between woody perennial plants and other plants and animals in each of the farm's plots, aiming to reach the objectives set by the manager of the farm.

- **Woody perennials: Woody** comes from **wood** and is any trunk, branch or vine that produces wood. **Perennial** means they live for a long time.

- **Interactions** Woody plants on a plot of land affect the crops and animals that live nearby. The effects between woody perennials and crops are called **interactions**. Interactions are effects or exchanges that occur between two actors, for example between shade trees and crops. Interaction are not always favourable, sometime they produce unfavourable effects.

- **Plot** is a part of a farm dedicated to a specific purpose-for example, a particular crop or for livestock, forest, fallow land or something else.

- **Lines** are property lines, internal divisions, internal roads, rivers or streams, rows of trees and any other bio-physical delineation that can be represented on a map using a line. Areas used for growing crops and for other purposes are called parcels.

- **Property lines** mark the boundary between two farms.

- **Line planting** is a group of plants (herbaceous, shrubs or trees) of one or various species, planted or recruited from natural regeneration, distributed along one or

various lines in parallel, following straight, curve or angle paths, and accomplishing objectives defined by the owners of the farm. Examples are living fences, windbreaks and contour plantings.

- **Segment** is a section of the line planting. A segment in the farm divides two given land uses or separate the farm from other farms, roads or rivers (boundaries).

- **Biodiversity** is the variety of living species animals and plants present in a given location.

- **Compatible** refers to being Well-matched or appropriate. A solution is compatible with the farm if it fulfills the farm's objectives and reflects the preferences of the farmer and his family.

- **Objectives** are the goals that a farmer and his family wish to achieve on their farm.

- **Thinning out** refers to removing trees. In line planting saplings may be thinned to increase spacing. In a plantation thinning is done to make open space for the remaining trees to grow strong and quickly.

- **Enterprise** is an activity carried out by individuals or groups of people to obtain an economic benefit or some other type of benefit.

HANDOUT 1: Forms

FORM # 1: Farm Map

What to include: Name and number each crop and pasture field, fallow land separated by age, forest patches, line plantings, gullies, bamboo clumps, relevant physical characteristics, exposure to winds, poor drainage and water stagnation, and rocky or shallow soils. Locate and number all line planting segments. Indicate North and landmarks, access roads, etc. If the farmer has more than one plot in different sites of the community then include more than one map.

FORM # 2a: Crop and pasture fields, fallow land by age, forests, spots with special characteristics. Importance rank according to farmer (1 = most important)

Fields (Land uses)	Area (acre)	Importance
TOTAL		**-**

FORM # 2b: Line plantings in the farm (boundaries with neighbours, internal roads and trails, field divisions, live fences, windbreaks, water courses, gullies). Length measured in meters. Importance rank (1-5) according to farmer (1 = most important)

Segment #	Length (Meters)	Importance
TOTAL		**-**

FORM # 3: Family structure, livelihoods and vision for the future Age and gender composition of the family, dedication to work in the farm (0 = does not work in the farm)

Family Member #	Male	Female	Age	Work in Farm (% Year)

Describe the livelihood strategy of the household (main sources of income, food and wood products for family consumption, use in farm or sale; farm and off-farm income such as remittances, pension, etc.).

Vision of the Future

Family	
Farm	

FORM # 4: Tree products (timber and non-timber) from the farm, current and desired. Timber products include lumber, firewood, charcoal, round wood, yam sticks, etc. Non-timber products include fruit, medicine, food or habitat for wildlife, etc.

Current		Desired (Future)	
Timber Products	**Non-Timber Products**	**Timber Products**	**Non-Timber Products**

FORM # 5: Inventory of trees and other woody perennial plant species (bamboos, palms, shrubs) in farm fields.

Field #	Species	Tree Counts	Total

FORM # 6: Inventory of trees and other woody perennial plant species (bamboos, palms, shrubs) in line plantings.

Segment #	Species	Tree Counts	

FORM # 7a: Summary of inventory of trees and other perennials in the fields and lineal plantings of the farm.

Species	Fields	Segments	Total

FORM # 7b: Yield and use of tree products in the farm, by species.

Species	Yield		Percentage of farm production (%)		
	Amount	Units	Sale	Self-Consumption	Lost

FORM # 8: Situational analysis of the family and the farm

SWOT – The Family

Strengths	
Weaknesses	
Opportunities	
Threats	

SWOT – The Farm

Strengths	
Weaknesses	
Opportunities	
Threats	

FORM # 9: Evaluation of proposed agroforestry innovations

Describe Innovation #1	
Describe Innovation #2	

Attribute	Score	
	Innovation # 1	Innovation # 2
Adoptability of the Innovation		
Superior		
Compatible		
Simple		
Feasible		
Results readily observed		
Climate-Smart		
Protect from storms		
Survive hurricane		
Survive drought		
Pass to my kids		
Quick rebound after storms		
Business-Savvy		
Easy to Sell		
Short term gains		
Long term gains		
Colllaborate in groups		
Diversifies income		
Cross Cutting		
Burdensome for women		
Minimize women's workload		
Increase income for women		
Household nutrition		
Youth opportunity		
Total		

Evaluating the Proposed Agroforestry Innovations

Definitions of Attributes

To narrow down agroforestry innovation options, complete this form in a participatory way with farmers. Yes = 2 points. Maybe/sometimes = 1 point. No = 0 points.

Adoptability of the innovation

1. It is superior, in other words, better than current situation?
2. Is it compatible with farm and family situation?
3. Is it simple and easy to implement.
4. Is it feasible? Can it be implemented with local resources and knowledge?
5. Can results be realized quickly.

Climate-Smart

6. Will it help in protecting the farm during bad storms?
7. Is it likely to survive a hurricane?
8. Can it survive a drought period well?
9. Will I be able to pass it on to my children?
10. Will it rebound quickly after an extreme weather event?

Business-Savvy

11. Will it give me products that are easy to sell?
12. Will it make the most money in the short term?
13. Will make the most in the long term?
14. Will it give me opportunities to collaborate with neighbours for purchasing inputs, processing, transporting and marketing?
15. Will it diversify the timing and sources of income on the farm?
16. Does the farmer already have familiarity with the markets for the intended product?

Cross-Cutting

17. Will it minimize the amount of women's workload in the family?
18. Will it result in the increased income for women?
19. Will it contribute to improving household nutrition?
20. Will it provide youth with skills, learning or business opportunities?

HANDOUT 2: Agroforestry Farm Planning (AFP)

AFP

The main purpose of agroforestry is to help farmers effectively manage the interaction between woody plants and the crops and animals on different plots of land on the farm. AFP allows producers to manage interactions in order to increase production, value and conservation on farm. AFP is applicable to farms of all sizes. AFP pays a lot of attention to the use and management of trees, shrubs, palms, vines and giant grasses like the bamboo on farm.

AFP is done in two stages: 1) An assessment or diagnosis and 2) The search for solutions (design). Now, we are going to see what AFP is all about; we'll discuss how it's done.

First stage: An **assessment or diagnosis is** all observations and examinations of the farm in order to find out what state they are in. There are many things to observe and analyze on a farm to determine its state of health, that is why the diagnosis is divided into three parts: 1. Biophysical, 2. Agroforestry and 3. Social and economic.

Biophysical Diagnosis

A biophysical assessment involves describing the parcels on the farm, how they are used, which crops are grown, how much each parcel measures and any special features of the land or the climate there. To carry out a good biophysical assessment we summarize the most important points in this chart:

1. Draw a map of the farm indicating clearly the plot and lines plantations. Examples of line plantings are the property borders, internal roads and divisions, gallery forests, windbreaks and everything that would be represented on a map with lines.

2. Include an special site description such as:

    a. Areas with steep slopes
    b. Rivers or creeks and natural draining areas.
    c. Low productivity areas such as swamps, cliffs, sandy or rocky areas.
    d. Noticeable variations in soils.
    e. Strong eroded areas.
    f. Areas exposed to high winds.

3. It is also recommended:

    a. Reconstruction of the land-use records, especially where there are many timber trees.

b. Listing the farms main opportunities and limitations

Agroforestry Diagnosis

Agroforestry diagnosis is a detailed description of how many parcels and linear plantations there are on the farm and the number of hectares and linear meters for each one. Farmers also must note the opportunities and limitations of each parcel and line. More detail is given to the perennial woody plants present on each parcel and line of the farm. It is necessary to prepare a census of the woody perennials on the farm, describing where they are, what they are and how many there are, the kind of goods and services they provide and how they interact with other plants or animals in each parcel and linear plantation. For each parcel and linear plantation we must answer the following five questions:

- Where are the woody perennials located in the farm?
- Which species of woody perennials grow in the parcel or line?
- How many plants of each woody perennial species are there in the parcel or line?
- Which goods or services does the farmer obtain from these woody plants in the parcel or line?
- Which favourable or unfavourable interactions do these woody perennials have with other crops or animals in the parcel or line?

Social and Economic Diagnosis

The social assessment helps farmers to understand the family's objectives and its relations with its social setting. The social setting or context is the group of organizations to which the farmer or his family belongs, such as cooperatives, associations or support networks. It also includes government institutions, churches, clubs and other organizations with which the family is involved, both in the local community and beyond.

The economic assessment describes the costs or expenses of the farm and the family. Also describes the ways in which the farmer and his family obtain their income, either in the form of money or of another type, for example, food or construction materials that are obtained from the farm, so we don't need to buy them. Following we propose a list of points to carry out a social and economic assessment.

The farm and family's main social and economic aspect are:

1. Describe the family group indicating each person's age and describe the activity each of them carries out.

2. Indicate the family's and each person's objective.

3. Indicate who the farm belongs to.

4. Indicate by whom and how decisions are made on the farm.

5. Tastes and dislikes are of the person who makes the decisions regarding wood species and crops.

6. Describe the family group's strengths and weaknesses, the degree of the family ties and the knowledge and specific skills of each member.

7. Describe the farm's relationship with markets, distribution network used, cooperatives or associations and access to credits.

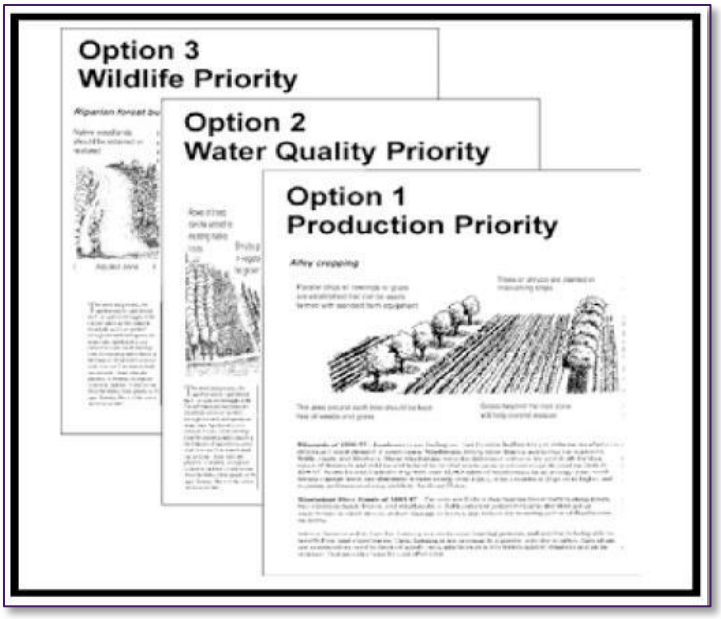
8. Describe all sources of incomes for the farmer ad his or her family, both cash and in-kind; as well as income used for expenses. Goods and services in kind that the family receives from the farm such as firewood for cooking, food for consumption, fodder for animals, construction materials, natural medicines and others must also be included.

9. Explain how the farmer and his or her family see their future as well as the farm's future.

SECOND STAGE: The Search for Solutions

After done a good assessment of the farm and family opportunities and limitations; farmers must find good agroforestry solutions to improve our farms. One solution is the whole set of actions that a farmer should carry out to improve the farm. These actions are mainly aimed at the woody component on the farm. The solutions will depend on the farm and on the state it's in. That's why we carry out an assessment first.

There's more than one way to get a job done…and some ways are better than others. Since the landowner makes the final call on what is better, it is important to prepare a range of viable options. Some optional designs may not be what the landowner originally had in mind and some may not even include agroforestry. But, good planning and design will ensure that each option can be achieving the objectives of the landowner. Present each option and help the landowner evaluate and compare them. To decide which solutions are best for the farm, you need to spend some time thinking, do some calculations and measurements, find out how much it costs to hire workers, the price of materials and study the market. It's also important to see if the proposed solution fits in with the farmer's plans and those of his family, taking into account their tastes and preferences.



Applying Solution at Farm Level

To apply a solution means to make some changes on our farm, or sometimes even try out things that are new. The experts say that most people resist change and innovation. Good or successful innovations, the ones that people accept, fulfill five requirements:

1. They are superior, in other words, better than current situation.
2. They are compatible with our farm and family.
3. They are simple.
4. They will be implemented with local resources and knowledge.
5. Results are available quickly.

From these five requirements, which do you consider is the most important?

To choose the best solution, you need to take those five points and discuss them with your family. Every farmer should ask himself which of those five requirements are most important to him and, according to that, gradually eliminate options until he's left with one or two very good solutions, with which he feels comfortable.

Concluding Remarks

The agroforestry planning process is a learning process for the resource professional and landowner. New information often leads to better assessments of the problem and limitations; changes in the priorities, and new or modified objectives. Revision represents an opportunity to apply that information and improve an agroforestry design. Planning for development of agroforestry in large areas, such as countries or watersheds, can fallow the same basic process that have been describe below but with two important

adjustments: 1) Emphasis is placed in identifying and addressing landscape-and community-scale resources issues and 2) Landscape assessments should pinpoint locations where the potential for agroforestry benefits are especially promising. A landscape-scale design can used as a guide by landowners, resource professionals and other site planners for blending their individual agroforestry practices with surrounding land uses to enhance benefits to communities and resources throughout the larger area.

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Module 5: Tree Nursery Management

Objectives

- To evaluate potential nursery sites;
- To plan and construct the nursery and make a nursery budget;
- To process and pretreat seeds; and
- To graft and other vegetative propagation methods.

In order to establish and maintain small tree nurseries, farmers will practice the critical skills throughout the entire nursery process.

Supplies

- Plastic Nursery Sacks (50/person)
- Flip Chart Paper
- Markers
- 2 Rakes
- 4 Hoes
- 2 Rulers
- 2 Shovels
- 5 Buckets
- 1 Wheelbarrow
- Organic Matter
- Sand
- Sieve
- 1 Roll Cord
- Water

Materials and Preparation Specific for Seed Pretreatment Activity

- Samples of Seeds from Different Species
- Flipchart Paper and Markers
- Tacks
- Mortar and Pestle
- Many Jars and Cans
- Edible Fruit Containing Seeds

Preparation

- Prepare nursery area for demonstration nursery;
- Prepare bare root nursery bed;
- Construct shade structure over bareroot site; and gather tools.

Venue

At proposed nursery site.

Total Time

6 hours

KEY RESOURCE

- Cocoa Nursery Manual_JA REEACH.pdf located in the accompanying flash drive.
- Good Tree Nursery Practices Manual_ICRAF.pdf.

Activities

This topics in this module will be covered through the three activities below:

Activity 1

- Nursery Planning and Design **(2 hours)**
- Initial Planning **(45 minutes)**

1. Brainstorm with group as to some of the major considerations that need to be taken into account before taking steps to establish a nursery.

REFERENCE

Some key questions that should be answered during this brainstorming session would be:

- For what purpose will the nursery be used?
- Will it be used to supply the group's seedling needs?
- Will it be used to supply group and external commercial needs?
- For commercial production what is the expected monthly demand for seedlings?
- Is there a particular nursery design that would be best suited for this operation?
- How will the group carry out research activities that will allow them to be able to estimate demand for specific tree seedlings?
- If the nursery will be used for external commercial purposes then what tree species does the group believes will be in most demand?
- Which of these in-demand species does the group believe it will be able to produce given the ecology of the area where they operate?
- What types of labour and material cost will be incurred?
- Where will we get our seeds?
- What is the estimated cost of nursery building material?
- What is the estimated total cost to operate the nursery annually and monthly?
- What is the estimated revenue from operations of the nursery?
- What square footage is required for the nursery?

Nursery Location **(15 minutes)**

2. Brainstorm with the group on some of the things that could go wrong in tree nurseries.

    a. Based on the results of the brain storming session have the sub-groups **develop selection criteria** that they will report out on and use to assess their proposed nursery site.

    b. After **assessing the proposed site using their own assessment tools** that they have developed the sub-groups shall again report on the score they have given to the site and compare their assessment with those of the other sub-groups.

REFERENCE

The following criteria are expected to be among those being used by the sub-groups:

- Protection from animals
- Water supply availability
- Micro-climate suitability
- Pest control
- Human control
- Out-planting locations
- Slope consideration
- Soil consideration
- Labour availability
- Sufficient space
- Land tenure
- Access to site
- Services available at site
- Drainage and wind protection
- Proposed orientation

c. Have group members develop a list using the table below as a template that they can modify for their specific purposes and report out by sub-groups.

Tree specie	Estimated group demand (quantity)	Estimated external demand (quantity)	Suitability of specie to the proposed location

Planning and Timing (30 minutes)

3. Re-engage the larger group in discussions as to the timing of propagation activities.

REFERENCE

Discuss with the group:

- When would be the best time of the year to commence seedling production?
- What time of the year will it be best to begin planting of seedlings?
- Is this process dependent on rainfall, temperature, humidity, etc?
- How long will seedlings be in the nursery?
- How long will it take for seedlings to reach the size for transplant?
- How many seeds or vegetative plantings will it take to get the quantity of plants desired?
- What will be a good surplus amount to set? How can this be estimated?
- What additional needs will fruit tree seedlings have than forestry seedlings?
- Will the group be using potting bags or planting in the soil?
- If potting bags are to be used what kind of potting mixes will be needed?
- Will the potting mix be prepared on site from local material or otherwise?
- If the potting mix is to be prepared from local material, what ratios will be used?
- How many persons will be required to operate the nursery? What are their costs?
- What activities will the labourers carryout in the nursery? Such as watering, weeding, shade management, insect pest management, transplanting, seeding and re-seeding, grafting, etc.

4. Instruct the group to arrange the activities involved in operating the nursery into groupings on flip chart paper so that they can be seen over time (preferably monthly) when operations are carried out. Note when costs are incurred or where revenue could be earned.

Nursery Budget (30 minutes)

5. After this exercise is complete and reported on and discussed by the group, begin another discussion on what it will take to properly operate a nursery, that is cost and operation considerations.

    - Discuss cost considerations and how the previous activity feeds into the preparation of a budget.

    - Discuss with the group the whole concept of assumptions and the requirement that they (assumptions) be conservative and be grounded in reality.

    - Introduce the table below to the group and have them discuss with you if this table will be able to assist them in developing a budget for the operation of the nursery.

NURSERY BUDGET

Group name and location:

DECSCRIPTION	UNIT	NUMBER OF UNITS	COST PER UNIT	TOTAL
INPUTS & SUPPLIES				
Sub-Total				
LABOUR				
Sub-Total				
CAPITAL ITEMS				
Sub-Total				
TOTAL - BUDGET				

Activity 2: Nursery Construction (2 hours)

1. **Design:** Instruct the group - with the assistance of someone with nursery experience – to sketch the nursery design showing show height, length, width, floor plan/layout, orientation, and any other critical features.

2. **Construct the Nursery**

   - Construction using the tools assembled should begin. Each group member must have assigned roles and responsibilities accompanied with the appropriate time requirement.

   - It is expected that the nursery will be completed over the course of the week by the group members and inspected by the group, the facilitator and subject matter expert to determine if the specifications agreed were adhered to.

   - Note: As soon as the nursery sacks and/or bareroot bed are in place, farmers should begin watering the nursery to sprout the weeds for removal before seeding.

Activity 3: Seed Pretreatment & Nursery Husbandry (2 hours)

Seed Pretreatment (60 minutes)

This unit will introduce the farmers to the main concepts and practices related to parent tree selection, seed collection, seed processing and storage, and seed pre-treatment. The activity will prepare the farmers to seed their nurseries.

1. Instruct the farmers to:

   a. Practice extracting seeds from husks;

   b. Conduct a conduct a seed germination test; and

   c. Pretreat seeds to be planted in the nursery using the appropriate pretreatment methods.

REFERENCE

Consider the following:

- Why is pretreatment required?
- Why might we need to do a seed germination test?
- What are the many ways we can pretreat seeds?

Nursery Husbandry (60 minutes)

1. Lead a discussion on nursery maintenance. Then move the discussion to the nursery area for the more hands-on topics. Topics to discuss are weeding, shade, nursery organization, runaway taproots, gnarly root balls, and community-realties.

REFERENCE

Opening questions could be:

- What operations are involved in the maintenance of a nursery?
- How much water does this nursery need and how often?
- Why do we weed?
- Pass around several potting bags and have farmers assess moisture content.
- Ask farmers to look at the nursery and determine if each pot has a seedling. If not begin a discussion as to why that might be (didn't germinate, rotted, died or killed (show fungus). What can be done as a result of this? (Reseed or transplant). Discuss reseeding.
- Discuss and give examples of trees of transplantable size.
- Demonstrate transplanting. Do not rip the root out. Loosen soil around seedling with a stick, make a good hole in the new pot with the stick, pull out the seedling gently. Do not pinch the roots, hold it by cotyledons. Place in new hole using a stick to make sure the root is straight. Work the soil around with the stick or fingers to pack against roots. Water well and place in heavy shade for several days until visibly recovered.
- Trouble shooting. What can you do? Look closely with the nursery manager to: compare seedlings; check under pots for termites; examine roots look for signs of pests (bird or rat droppings, frogs hiding between pots, etc.); and examine the soil for green algae.
- Show farmers an overgrown, root bound seedling. Have each trainee pull one up, noting breaking, ripping of taproot. Open sacs to observe root structure and root curl. Why don't we want this? Root curl creates poorly formed roots that are inefficient and lead to poorly formed trees.
- What can we do to prevent runaway taproots and gnarly root balls? Trim roots by moving the pots every two weeks, make good timing calculations, and avoid overgrown seedlings.
- When and why do you need to reduce shade? Reducing shade minimizes spindly seedlings and fungus problems. It also speeds up growth. Most species we work with hardly need shade with the exception of many of the fruit trees. Hotter areas may demand more shade.

Activity 4: Vegetative Propagation (2 hours)

Grafting (60 minutes)

1. Demonstrate all of the following steps, and then check all participants to make sure they also have performed them correctly. It is better to have several trained assistants to help with this process.

STEP-BY-STEP GRAFTING PROCEDURES

Place all materials as follows on a large table and ask all participants to come close and watch carefully:

- Using the grafting knife, cut into the stem of the root stock below the cotyledon
- Cut in horizontally as far as the cambium layer and no farther
- Peel the skin downward about 5 cm.
- Wrap some tape around the skin which has just been peeled back.
- Using the pruning shears cut a section of the branch with one leaf on it.
- Cut the leaf half way back
- Shave the bottom end of the segment into a sharp wedge
- Place the sharp wedge inside the tape and flat against the cambium layer of the root stock and press downward so the fit is tight.
- Wrap more tape around the graft, making sure not to wrap tape over the top end of the grafted branch.
- Water the grafted seedling and cover with a plastic bag to keep the entire seedling moist for 2 weeks
- Wash the grafting knife with alcohol
- Return every day to water the grafted seedling
- In two weeks time take off the plastic bag and to cut loose the tape around the graft so the tree can grow

Group members must arrange for the proper watering and care all seedlings and grafted plants in the nursery.

Other Types of Vegetative Propagation (30 minutes)

2. Besides grafting, ask farmers which other vegetative propagation methods the farmers are familiar with. Practice a vegetative propagation technique if applicable to range of species that the farmers are intending to plant in their agroforestry plans.

    - Discuss, demonstrate and practice cutting suckers (such as with bananas);
    - Discuss, demonstrate and practice air layering (such as with naseberry);
    - Discuss, demonstrate and practice planting cuttings (such as with Gliricidia or Neem); and
    - Discuss, demonstrate and practice using root cuttings (such as with breadfruit).

Daily Summary and Observation Analysis

At the end of each of the activities reconvene the farmers in a circle at the end of the session. Facilitate the daily summary by asking questions such as:

- What did you think about the work today?

- What was easy about today's activities?
- What was difficult in today's activities?
- What observations do you have?
- Why is it important to have nursery planning?
- What are the critical practices for nursery maintenance?
- What should we consider in choosing a nursery site?
- To which problems is our nursery most susceptible?
- What are the critical guidelines for pretreating seeds?
- How do you plan to apply grafting and other vegetative propagation methods on your farms?
- What are the advantages of working together?
- What costs are involved and how can we decrease costs?

Handouts

Handout 1: Small-scale Tree Nurseries
Handout 2: Tree Seeds Overview & Pretreatment
Handout 3: Notes on Grafting

HANDOUT 1: Small-Scale Tree Nurseries

Nursery Planning

Species

Determine which species are appropriate for the intended agroforestry results. This will influence all the other decisions you will make about the nursery. What species are well suited to the environment? To the task? What trees are your farmers interested in working with? Do you want to use local or exotic species? Pros and cons?

Proper Timing

1. Out planting and direct seeding at beginning of rainy season

2. Generally we should be starting nurseries in June for a September or October out planting

3. Three to four months is an average length for species in a nursery

4. The proper size for transplanting and/or outplanting depends on the species

Planning for Germination Numbers

Discuss idea of planning surplus of 20% or more, depending on objectives and skills of the farmer. For the example of the windbreak, if we needed 1000 trees, how many would we want to grow in the nursery? How many seeds would we need? How can we allow for a low germination rate? How can we ensure we are able to select only the best seedlings for outplanting?

Which type of soils should be used and why?

- If you have fabulous soil, great! But more often than not you will have to modify the soil, regardless of whether you are using polypots, bare-root or direct seeding.

- Mixture should be 2 parts pure sand and 1 part manure (both should be sifted if possible because large pieces of manure will burn a young seedling due to the amount of nitrogen).

- The presence of heavy clay soils will have a negative effect on rate and time of germination.

Labour

Who is going to take care of the nursery?

Methods of Propagation

Discuss the fact that some species are better in certain methods of propagation. Lead farmers in a discussion of the pros and cons of each propagation method.

1. **Polypots** Tree pot sizes

Pros: Can choose and control site (shade, fencing, pests, etc…)
Can pamper seedlings
Roots are not damaged in outplanting

Cons: Expensive
Is it sustainable?
Tree is pampered - may not be tough

2. **Bareroot**

Pros: Cheap- no cost!
Less weight to transplant open-rooted stock
Takes less time to transplant open rooted stock

Cons: May damage root in transplanting or transport
Susceptible to pests (can't move 'em)

3. **Cuttings**-Nursery or Direct

Pros: Some species only suited to this
You know what you're getting
Fast

Cons: Bulky to transport cuttings
Cuttings don't develop deep taproots

4. **Direct Seed**

Pros: Cheap
Easy- no watering involved if timed right
Sustainable

Cons: Susceptible to pests- bugs, goats, cows, etc…
Seedlings must be protected
Trees are not given a head start before the rainy season

5. **Natural Regeneration**

Pros: Easy- no labour
NO COST
Sustainable

Cons**:** Trees may not be where you want them
No control over where or when trees occur

Choosing the Nursery Site

Considerations in the Site Selection of a Nursery

Ask the group to brainstorm ideas on what could go wrong in nurseries. Based on this, what are the site selection criteria?

1. **Protection from animals** - Fencing (types - wire, thorn, living fences, chicken wire, gate) and low animal traffic areas

2. **Water supply** - Distance, labor involved and reliability

3. **Microclimate** – Shade for protection for young or sensitive seedlings. Know your site and how much sun it will have. It is best if the site can be manipulated in order to control sunlight and wind exposure.

4. **Pest Control** - Termites, hiding spots and keeping seedlings away from fences.

5. **Human Control** – Avoid places where people pass by each day, can supervise without extra effort, away from kids, will it be this way the whole lifespan of the nursery (such as an abandoned garden)?

6. **Outplanting location** - Is the final outplanting site far away? Will transporting damage seedlings? Build nursery closer to outplanting site if possible.

7. **Slope considerations** - Is there adequate drainage? Flooding?

8. **Soil considerations** - A soil sample should be taken

9. **Labor considerations** – Do we need a nursery manager or caretaker?

10. **Sufficient space** for anticipated seedling demand - expansion

11. **Land ownership** – Who owns the nursery location?

Some Nursery Maintenance Issues

- ***What operations are involved in the maintenance of a nursery?***

  (Watering, weeding, adjusting shade, troubleshooting, pest management, transplanting, reseeding, organizing the nursery, root trimming, hardening off, keeping a clean nursery attracts less pests.)

- ***How much water does this nursery need and how often?***

  (Enough to be continuously moist, but never soggy!) Especially true early on when seedlings are vulnerable to drought and fungus problems. Generally this means twice daily. Generally people overwater. As seedlings become more mature, they become less sensitive to drought and/or soaking. Two watering cans daily should be

enough for 250 seedlings, but don't rely on calculations. Test the pot soil with your finger.)

- ***Why do we weed?***

  (To diminish competition for nutrients, remind you which one is the seedling. Explain that farmers may not be able to distinguish between the weed and tree seedlings. Have farmers weed existing pots. Help farmers distinguish seedlings.)

- ***Pest Management***

  (Pests can be serious issue. We'll deal with them as they arise. Explain that all farmers will have a session on Integrated Pest Management.)

- Comment on the need to **organize trees** by species and size as one transplants, reseeds.

- **When you plant your seedling in Jamaica, is it going to get water and care every day?**

  (NO! Climate is variable and harsh, stresses numerous, labor time scarce. How can we toughen up our pampered seedling? Gradually reduce watering frequency and amount. Make sure plant is adapted to full sun. How soon before planting would you want to do this? Generally three weeks before planting.)

HANDOUT 2: Tree Seeds Overview & Pretreatment

Where do we get tree seeds?

The facilitator asks the question "Where do we get tree seeds?" and captures responses on a flipchart. The facilitator should add to the list with research he/she has done previously. Once there is a list of sources, discuss with farmers the advantages and disadvantages of each: **(10 minutes)**

a. **Local market or roadside** - the disadvantage is that the date of collection is unknown, the seeds may no longer be viable or may have been stored incorrectly, and the physical characteristics or genetic makeup of the parent tree is unknown.

b. **NGOs** - the disadvantage is that the seeds are often in short supply and one may have to pay for them, which can be expensive. Plus, the question of sustainability comes into the picture.

c. **Other farmers** - the disadvantage is that they may just get any old seeds and probably not be selective at all.

d. **Do it yourself** - the advantage is that you know the health of the parent tree, its physical characteristics and the ecological conditions under which it has existed. The disadvantage (joking) is that you need to focus and participate in this FFS to learn how to do it!

Selection and Collection Guidelines

The facilitator shares selection and collection guidelines with the aid of flipcharts. **(10 minutes)**

- Harvest only mature seed from ripened fruits.
- Collect same species seeds from a distance of 100m from any other collection of the same species. This is for genetic diversity. It reduces the possibility of inbreeding that can occur when seeds drop and sprout close to the mother tree and crossbreed with it.
- Avoid trees that are isolated from others of the same species. This limits genetic diversity.
- To ensure genetic variation, collect fruits equally from all parts of the crown-top, sides, and bottom, as these parts may have been pollinated at varying times from different sources (use long sticks with sharp ends that the women use to collect firewood to get to high places).
- Collect throughout a species normal habitat, noting variations in site. Include trees that cover a broad geography and environmental extremes.

- Man-made stands like live-fencing, plantations, or windbreaks should be carefully reviewed as to their establishment before being selected as a seed source.

Processing

Cut up fruit (mangos, oranges, and papayas)

- Removing husks:

  - ✓ Husks are home to insects;
  - ✓ Husks are home to larvae;
  - ✓ Husks attract many pests; and
  - ✓ Husks are bulkier to store (demonstrate mortar and pestle).

Other factors

- Pick out bad seed (disfigured, irregular form, boring insects) – have a farmer go through a handful of seed and explain why he or she discarded certain seeds.

- Dry in shade after washing/removing membrane (such as citrus species, papaya, and orange)

- Dry to avoid rot through moisture build-up in an enclosed environment

Storage

The facilitator states that now that once seeds are processed, they need to be stored. Then lead discussions on factors related to storage

- Moisture:

  - ✓ Causes rot ;
  - ✓ Make sure seeds are dry when placed in storage and remove lids once per month to expel built up moisture; and
  - ✓ To check for larvae which could have hatched

- Temperature:

  - ✓ Keep in a cool and dark place;
  - ✓ Some species cannot survive in temperatures above 40°C;
  - ✓ Fruit tree seeds should be refrigerated and may only be stored for a short time; and
  - ✓ Acacia seeds may be stored in cool places for several years.

- Atmosphere

  - ✓ Containers should be kept off floors and away from walls due to insects and dampness; and

- ✓ Keep containers so that air can circulate around them as this helps with cooling and dryness.

- Containers

  - ✓ Plastic-(pros)-no light, non-breakable, dark, (cons)-pests esp. mice, can't see the seed;
  - ✓ Glass- (pros)-can see the seed, mice and pest safe, (cons)-breakable, prone to light disturbance; and
  - ✓ Metal-(pros)-no light, non-breakable, no pests, (cons)-can't see.

- Knowledge

  - ✓ Species - NAME
  - ✓ Collection - DATE, LOCATION, NAME OF COLLECTOR
  - ✓ Storage - BEGINNING DATE TREATMENT
  - ✓ Quantity

- Pest Control

  - ✓ Store in ash; and
  - ✓ Shake the jars often.

Seed Morphology

The facilitator discusses seed morphology and describes the function of seed components. **(5 minutes)**

What are the major parts of a seed?

a. **Radicle** - the plant's complete root system develops from these cells.

b. **Cotyledon** - the two primary leaves; these are the first leaves seen when the plant emerges. They are generally thick and waxy and look different from the true leaves that emerge later.

c. **Endosperm** - the food for the seed.

d. **Seed coat** - protects the seed embryo (the living part).

e. Area where seed coat may be safely scarified.

Does a sapling always look like the mother tree?

- Discussion of forestry (epigeous) vs mango/citrus (hypogeous)

What makes seeds germinate?

a. Alternate heating and cooling;
b. Alternate wetting and drying;

c. Fire;
d. Passage through animal tract;
e. Activities of soil organisms, fungi, and insects; and
f. Sensitivity to day length.

NOTE 

The facilitator emphasizes that in pre-treatment we imitate nature's methods of breaking seed dormancy.

Pretreatment

Why is pretreatment required?

a. All seeds must absorb water to germinate;
b. Some seeds have waxy seed coats that keep them from absorbing water;
c. Some seeds have hard, thick seed-coats that keep them from absorbing water; and
d. Seed treatment assures seeds germinate at the same time.

Why might we need to do a seed germination test?

- The facilitator describes a seed germination test and explains the rationale for using one. It is a method in determining seed viability if the seed source is unknown. **(5 minutes)**

What are the many ways we can pretreat seeds?

The facilitator discusses and demonstrates various types of pre-treatment methods and emphasizes that the type of pre-treatment depends on the seed. When possible, the facilitators give examples of species which require each of these pre-treatments: **(5 minutes)**

a. **Hot or cold water soak** - usually 4-24 hours; generally seeds with harder seeds coats get hot water.

b. **Air dry then cold soak** - air dry seeds, then soak in water before planting, generally *Azadirachta indica, Carica papaya.*

c. **Clipping and/or scarifying** - use nail-clippers, do not cut radicle or cotyledon; clip a little at a time, until you see a white interior, the endosperm; technique used for *Leucaena* and *Acacia* species; to scarify, use rough surface to break seed coat, i.e. sandpaper or a rock.

d. **Acid bath** - dip in sulfur, this is never done by anyone we know!

HANDOUT 3: Notes on Grafting

- **Introduction of Grafting**

  - ✓ Difference between grafting and topworking.

- **Benefits of Grafting**

  - ✓ Improve the quality or quantity of the fruit;
  - ✓ Change the fruiting time of the tree;
  - ✓ Improved characteristics deriving from the rootstock (ie. disease, salt, drought-resistance); and
  - ✓ Guarantee characteristics of scion.

- **Rootstock Selection**

  - ✓ Select healthy, hardy trees with good root system characteristics; and
  - ✓ Topwork trees for those wanting to improve fruit or change timing.

- **Scion Selection**

  - ✓ Select cuttings from healthy trees with desired fruit characteristics.

- **Rootstock Preparation**

  - ✓ Nursery trees:
    - One year old minimum, pencil width, well-watered for at least one month before grafting.
  - ✓ Topworked trees:
    - Cut off all but one branch.
    - Select 2-3 stems per branch and remove all others one week before grafting.

- **Scion Preparation**

  - ✓ Select scion branch and remove all leaves for 20 cm to promote swelling of the buds;
  - ✓ 7-10 days later remove for grafting;
  - ✓ Scion width should be of equal or smaller diameter than rootstock; and
  - ✓ Do not take from flowering trees.

- **Grafting Techniques (Importance of Cambium Layer)**

  - ✓ Tongue and Groove method;
    - Give example and outline procedure.

  - ✓ Budding method;
    - Give example and outline procedure.

- **Follow-up**

  - ✓ Periodically check on grafts for the next ten days and remove outer plastic wrapping when the bud has started to sprout (usually 10-15 days).

  - ✓ Keep final wrap tight to protect wound and remove when the union has hardened and scion is sprouting (usually two months). *For tongue and groove.*

  - ✓ Cut off everything above the grafting point on the rootstock stem and prune all new shoots not originating from the scion.

Module 6: Land Husbandry

Objectives

- To understand the principles of land use capability according to land categories
- To recognize the basic interactions between soil and water and their impact on soil erosion and land stability
- To adequately identify soil, land and water resource vulnerabilities resulting from climate change exposures
- To construct an A-frame and use it to find the contour of the land
- To apply the most appropriate soil erosion control measures on their holdings.

Materials

- GPS units
- Material and tools to construct A-frames
  - ✓ Two (2) straight 2" x 1" pieces of wood, each 2 m long
  - ✓ One (1) straight 2" x 1" pieces of wood 1 m long
  - ✓ Six 2" screws
  - ✓ One (1) small spirit level
- Six (6) Jumbies (straight wooden or metal rod) 45 cm long
- Mallet or hammer
- Five (5) plastic transparent containers
- Filter paper and water
- Labels and markers
- Two (2) large, clear plastic bags
- Flip chart paper
- Vetiver grass or other materials for vegetative soil conservation
- Scissors
- Four (4) plastic cups
- String
- Four (4) 2-liter water bottles
- Three distinctly different types of soil (clay, silt and sand)
- Organic material/compost
- A bucket of water

Preparation

Before training session prepare flip charts with the following headings:

- Land use capability;
- Factors influencing erosion process and landslide;

- Soil conservation or land stabilization methods; and
- Erosion mechanism and control methods.

Venue

Demo plot or group member field that is sloping with sparse tree and exposed soil.

Total Time

6.5 hours in 3 sections

ACTIVITIES

Activity 1: To Understand the Influence of Soil Types on Water Runoff and Seepage

(30 minutes)

AFESA begins - Farmers are divided in groups then, walk, observe field and collect insect, weed and disease specimen. The field shall be traversed in such a manner that the results would be representative of the entire plot the observations made and specimen collected must always form part of a more general AFESA discussion.

NOTE

SIXTY MINUTES

- Punch one hole at the bottom of each bottle.
- Cut and hang bottles as shown in picture below.
- Fill three cut bottles three quarter way full with one of the three (3) soil type material and one cut bottle with compost or organic material. Compact the soil samples added to the cut bottles equally.
- Ask the farmers what they think will happen when the same amount of water is poured gently into each cup.
- Pour the same amount of water on each sample in the cut bottles.
- Place cups underneath the bottles on the ground to collect the water.
- Have each smaller group note their observation.
- Return 30 minutes to make some more observations.

REFERENCE: DISCUSSION QUESTIONS

- Which one of the cut bottles allows water to past fastest and why?
- Which one of the cut bottles allows water to past slowest and why?
- What differences do you see in the quality of water that exits out the bottom?
- What does this show about the seepage of water through the different soil types on a slope?
- What implications does this have for leaching of chemical fertilizers?
- What does this show about the role of organic material in the soil?
- How might the canopy cover affects the rate at which water infiltrates the soil?
- How might the canopy cover affect the rate of water runoff from a slope?

Activity 2: To Diagnose Soil Erosion and Select Land Stabilization Options

(30 minutes)

AFESA begins - Farmers are divided in groups then, walk, observe field and collect insect, weed and disease specimen. The field shall be traversed in such a manner that the results would be representative of the entire plot the observations made and specimen collected must always form part of a more general AFESA discussion.

(30 minutes)

- The facilitator will engage farmers in a discussion on the effect of water erosion in their fields.
- Discuss with farmers how water flowing over small channels can cause them to become large, deep and unstable areas in the farm.
- If available use before and after pictures of similar features that have developed elsewhere with similar topography to their fields or communities.
- Introduce the concept of land use capability.
- Brainstorm on the factors that influence the erosion process and landslide.
- Discuss soil conservation and land stabilization methods and have the farmers highlight the methods that they use in their fields and give reason for their choices.
- Discuss the mechanisms by which soil can be eroded.

(30 minutes)

- On the field map developed from the initial AFESA or D&D ask farmers to identify areas where they have observed soil loss taking place.
- Additionally the map should show – if not already included:

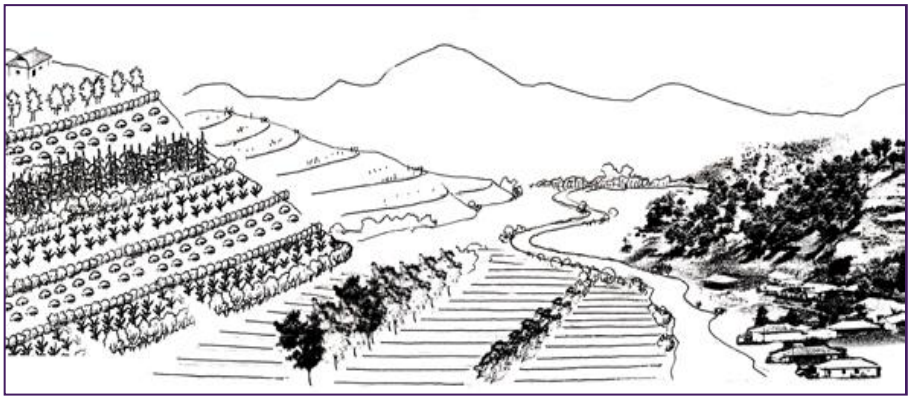
- ✓ Roads, hills, valleys, water bodies;
- ✓ Farm water collection points;
- ✓ Areas that are cultivated;
- ✓ Grazed and forested; and
- ✓ Degree of land slope.

Operation 1: **(1 hour)**

- Have the farmers identify six (6) locations spaced roughly evenly and going generally in a down-slope direction for the insertion of the jumbies.
- Drive jumbies into the soil to a depth where it is securely anchored in the soil and a small piece of the jumbie left above the soil.
- Measure the tip of the jumbie remaining above the soil and record it.
- Ask group members to take monthly readings of the protruding tips length from the soil surface
- On the occasions when these readings are taken discuss with the group the implications of the readings.

Operation 2: **(1 hour)** *(When the opportunity presents itself.)*

- After an intense rain shower, have the group visit the field
- Observe and note the areas where water flows fast and where rills or gullies have developed
- Determine the source (entry point) where the water entering the land
- The group should map the movement of the water on the AFESA map that was developed earlier in the AFFS
- Group members must brainstorm and agree actions that they can take to stem the destructive flow of the water.



Soil and water conservation along the landscape.

REFERENCE: DISCUSSION QUESTIONS

- Where on the field map are the areas where soil erosion is a concern?
- Where is the source of the water that causes the erosion concern in the field?
- Can spot filling help to reduce soil erosion, how?
- What opportunities are there for the use of the runoff water?
- What are the possible erosion control options in the field?
- It the source of the water causing the erosion is coming from a neighbour's field what can be done about this.
- If the protruding tip of the jumbie increases in length what is the significance of this?
- What are some of the features that can develop in the field over time with unchecked rainwater flowing through it?
- If roots of trees in the field become exposed over time what could be the significance of this?
- Can trees in the field be threatened by water erosion and how?
- What is the significance of top soil loss to the farmer?
- How do the land characteristics influence the selection of the crop planted in the community and soil/water management practices?
- How does soil depth and soil moisture vary according to slope and position of the fields?
- Which parts of the community are more affected by runoff and soil erosion?
- Which are the main problems in the different sections of land, and what are the causes of these problems?
- What management practices are currently in use for conserving the land in your village?

NOTE

Researchers have calibrated the changes in length of the protruding jumbie tip with soil loss, 1mm of soil depth change measured by the "Jumbie" is equivalent to a loss of 15 ton/ha/yr - Hudson, 1987.

Activity 3 (2 hours)

A-frame Construction and Contoured Soil Conservation Structures

(30 minutes)

AFESA begins - Farmers are divided in groups then, walk, observe field and collect insect, weed and disease specimen. The field shall be traversed in such a manner that the results would be representative of the entire plot the observations made and specimen collected must always form part of a more general AFESA discussion.

(45 minutes)

Farmers will be taken through the process of constructing an A-Frame for use in determining areas of equal altitude in the field in order to established appropriate soil conservation measure.

- Conduct a brainstorming session on the use of the A-frame;
- Participants in small groups of 4-5 persons should proceed to construct A-Frame; and

PROCEDURE: CONSTRUCTING AN A-FRAME

1. Screw the two long 2 metre pieces of wood tightly together at the top;
2. Insert the spirit level midway along the length of the 1m piece of wood;
3. Screw the 1 m long piece of wood to one of the 2 m pieces midway along its length;
4. Stretch the short piece of wood across the two pieces of wood to form the shape of the letter 'A';
5. Make the A-frame stand upright on a level floor and adjust the cross piece until the spirit level is centred;
6. When the level is centred mark the position of the cross piece on the second 2 m piece of wood; and
7. Screw on 2-inch square of wood below the mark so that the cross piece can rest on it at.

- Facilitator or subject matter expert (FSME) must now demonstrate and allow farmers to practise using an A-frame on slopes to map areas of the field with similar contours.

NOTE

Soil conservation measures such as vegetative or mechanical barriers should be established along the contour.

Every time before using the A-frame, check its accuracy on a level floor If it is possible carry out this exercise before any soil disturbance.

NOTE

STEPS IN THE OPERATION OF THE A-FRAME

Pegging with an A-frame requires at least two people.

1. Go to the centre of the field and mark it with a peg. Place one leg of the A frame right next to the peg.
2. Hold this leg in place while slightly moving the other leg up and down the slope until the spirit level is dead centre. Mark this point on the ground with a second peg.
3. Pivot the first leg around while holding the other leg at the second peg. Move the first leg slightly up and down the slope until the spirit level is again dead centre. Again, mark this point on the ground with a third peg.
4. Continue like this until reaching the field boundary.
5. Return to the centre of the field where the very first peg was placed and move in the opposite direction to the other end of the field following steps 2-3.
6. Run lines from the first centre peg to all pegs on both sides of the field..

(30 minutes)

- After the demonstration and practise has been complete the group should proceed to use the A-frame to map areas of the field with similar contour.

NOTE

That not all the field will be contoured using the A-frame in this timeframe and as such it is expected that the farmers working in their groups will plan a work day where they would apply what they have learnt to complete contouring the field.

- In the sections that have already been contoured by the group the FSME will refer to the map where the erosion problems were identified and options discussed with the farmers to brainstorm and agree on possible land conservation measures to implement along the contour lines. ***(A basket of options are included in the reference material as a guide to facilitators not very familiar with these structures or measures.*)**

- The group must now assign roles and responsibilities to members for execution.

Picture of an A-frame

REFERENCE: DISCUSSION QUESTIONS

- What is soil conservation efforts aimed at?
- How is mulch used in land conservation?
- What can be done with plant material that has been pruned in a sloping field?
- How does mulch help to conserve water?
- Is contour farming an effective soil and water conservation strategy for upland farming, explain?
- What are live contour barriers?
- What are some plant species that can be used as live contour barriers?
- What are some materials that can be used as non-vegetative contour barriers?
- Apart from contour barriers name and describe other soil conservation measures.

Handout

Facilitator's Resource

Handout 1: Soil Conservation Measures
Handout 2: Ja REACH Vulnerability Assessment Form

HANDOUT: Facilitator's Resource

More than 75 per cent of Jamaica land has slope of 10 degrees or more. This severely limits potential for agricultural production and poses great risk for environmental degradation. A United Nations report in 1992 revealed that over half (53 per cent) of Jamaica's 407,434 ha is only suitable for forestry. A further 10 per cent is considered suitable for tree crops and pasture with "extreme shortcoming for cultivation". Thirty-four per cent is suitable for farming but with 'strong' or 'moderate' limitations, leaving only three per cent, which is considered usable with no limitations.

Soil erosion is therefore a major issue, as these sloping areas are planted mainly with cash crops which provide minimal soil cover. Coupled with high rainfall, soil erosion normally leads to excessive soil nutrient depletion. The difficulties become even more apparent considering that the average small farmer is elderly and rooted in tradition with low literacy.

Other factors which contribute to the problem of soil erosion are the practice of short-period tenancy, which gives the proprietor little interest in conserving the fertility of his land, and the system of renting land for the production of one type of crop only. Some fundamental changes in the current agricultural practices will be needed if further loss of valuable soil is to be prevented.

Factors Influencing Soil Erosion

***Rainfall pattern**:* The more rainfall and the higher the "force" of the rain (called the intensity, i.e. the amount of rain which falls per minute), the more erosion will occur.

Slope steepness: The steeper the field, the higher the erosion risk.

Slope length: Erosion increases with slope length.

Soil type: Clayey soils show in general more resistance to erosion than sandy soils.

Erosion control structures: Well-established and well-maintained erosion control structures can be very effective. But when such structures are poorly established or poorly maintained it is possible that they accelerate erosion.

Cropping practices: Varying cropping practices have different effects on soil erosion.

Groundcover: Groundcover protects the soil surface from the impact of rainfall.

Time: Soil erosion (as well as soil development) is a function of time.

HANDOUT 1: Soil Control Measures

There are three major categories.

1. Agronomic Interventions

These are measures undertaken within the cropping area for crop production purposes and include practices such as intercropping, contour cultivation, minimum tillage, mulching, use of organic matter , etc. which:

- Are usually associated with annual crops;
- Are repeated routinely each season or in a rotational sequence;
- Are of short duration and not permanent;
- Do not lead to changes in slope profile;
- Are not zoned; and
- Are independent of slope.

2. Vegetative Soil Conservation Means

These measures involve the deliberate planting of trees, shrubs, grasses etc, or retention of areas of natural vegetation (e.g. reforestation, contour hedgerows, and natural vegetative strips) which:

- Involve the use of perennial grasses/pasture legumes, shrubs or trees;
- Are of long duration;
- Often lead to a change in slope profile;
- Are often zoned on the contour or at right angles to wind direction; and
- Are often spaced according to slope.

Hedge row planting of vetiver

3. Structural Erosion Control Methods

Measures which involve the construction of physical structures (e.g. graded banks or bunds, contour stone lines, level bench terraces, artificial waterways and drop structures) which:

- Lead to a change in slope profile;
- Are of long duration or permanent;
- Are carried out primarily to control runoff and erosion;
- Require substantial inputs of labour or money when first installed;
- Are zoned on the contour; and
- Are spaced according to slope.

Land terracing

Stone Barriers

HANDOUT 2: Ways to Conserve the Soil

Soil is one of the most important natural resources. It is one of the three main factors responsible for plant growth, the others being sunlight and water. Plants extract water and nutrients from the soil. A food chain, as we know, starts from plants and plants need soil for their survival. So soil is an important constituent of the ecological system and its conservation is essential. But the importance of soil conservation is relatively less talked about as compared to conservation of water and other natural resources. The almost-omnipresent soil is taken for granted. We don't pay much attention to conserving it. We rarely even think of it as a natural resource or as a part of the natural wealth that needs to be preserved.

The idea of conserving soil is to prevent it from being eroded and from losing its fertility due to alteration in its chemical composition. Here are some ways to conserve soil.

1. **Plant Trees:** We all know that roots of trees firmly hold on to the soil. As trees grow tall, they also keep rooting deeper into the soil. As the roots of trees spread deep into the layers of soil, they hold it tightly, thus preventing soil erosion. Soil under a vegetative cover is saved from erosion due to wind as this cover acts as a wind barrier.

2. **Build Terraces:** Terracing is a very good method of soil conservation. A terrace is a levelled section of a hilly cultivated area. Owing to its unique structure, it prevents rapid surface runoff of water. Terracing gives the landmass a stepped appearance, thus slowing the washing down of soil. Dry stonewalling is a method used to create terraces in which stone structures are made without using mortar for binding.

3. **No-till Farming:** The process of preparing soil for ploughing is known as tilling. No-till farming is a way of growing crops without disturbing it through tillage. The process of tilling is beneficial in mixing fertilizers in the soil, making rows and preparing the surface for sowing. But the tilling activity can lead to compaction of soil, loss of organic matter in the soil and the death of soil organisms. No-till farming is a way to prevent the soil from this harm.

4. **Contour Ploughing:** This practice of farming on slopes takes into account the slope gradient and the elevation of soil along the slope. It is the method of ploughing across the contour lines of a slope. This method helps in slowing the water runoff and prevents soil from being washed away along the slope. Contour ploughing also helps in percolation of water in the soil.

5. **Crop Rotation:** Some pathogens tend to build up in soil if the same crops are cultivated again and again. Continuous cultivation of the same crop also leads to imbalance in the fertility demands of the soil. To save the soil from these adverse effects, crop rotation is practiced. It is a method of growing a series of dissimilar crops in an area. Crop rotation also helps in the improvement of soil structure and fertility.

6. **Maintain Soil pH:** The contamination of soil by addition of acidic or basic pollutants and due to acid rains has an adverse effect on the soil pH. Soil pH is an indicator of the level of nutrients in soil. The uptake of nutrients by plants also depends on the pH of soil. Maintaining the correct value of soil pH, is thus essential for soil conservation.

7. **Water the Soil:** We water plants, we water the crops, but do we water the soil? We seldom do. Watering soil is a good measure of soil conservation. Watering the soil along with plants growing in it is a way to prevent soil erosion caused by wind.

8. **Salinity Management:** The salinity of soil increases due to excessive accumulation of salts in the soil. This has a negative effect on the metabolism of crops. The salinity of soil is detrimental to the vegetative life in it. The death of vegetation leads to soil erosion. Hence, salinity management is an indirect way of conserving soil.

9. **Promote Helpful Soil Organisms:** Nitrogen-fixing and denitrifying bacteria are important constituents of the nitrogen cycle. They live in soil. Bacteria and fungi help keep the soil healthy. Organisms like earthworms help decompose organic material in the soil. They aid soil aeration and help it maintain porosity. Rodents too, help soil the same way. This increases the absorbing capacity of soil. Earthworms, through aeration of soil, enhance the availability of macronutrients. These helpful organisms boost soil fertility and help in soil conservation.

10. **Grow Indigenous Crops:** Planting native crops is beneficial for soil conservation. If non-native plants are grown, fields should be bordered by indigenous crops to prevent soil erosion, thus achieving soil conservation.

Module 7: Windbreaks

Objectives

- To design multipurpose windbreaks that meet socio-economic needs of the family;
- To establish a windbreak to address wind erosion concerns in the demonstration plot; and
- To establish windbreaks that minimize damage to crops and fields from storms.

Supplies

- A Guide for the analysis of line plantings;
- Seedlings to plant during the session;
- Flip charts; and
- Measuring tape and wooden stakes.

Preparation

Work with the farmers to select a family who has line plantings in their field and are willing to allow the AFFS group to improve the design and consistency of planting arrangements.

Venue

Farm with trees in line plantings along the boundaries or inside the field.

Total Time

Approximately 3-4 hours

Summary

The session starts with an explanation of the main concepts (definitions) to be used. Similar to previous agroforestry design activities, the AFFS participants will map the existing land, interview the family, determine how trees in the windbreak can meet needs of the family, and design windbreaks according to the technical guidelines and socio-economic drivers.

Activities

Activity 1: **Drawing a sketch of the farm** - The facilitator and members of the family owner draw a sketch of the farm on a flip chart **showing current or potential line plantings (boundaries and internal divisions)**. The segments of line plantings must be numbered and, if possible, note the lengths of the segments.

Activity 2: **Interview the family** - Facilitate a discussion among the family and farmers to identify the family's objectives and future vision for the line plantings.

- What trees do they value on their farms?
- What goods and services do they want from them?
- Is space a concern?
- What products do they hope to get from tall trees?
- Which products do they hope to harvest from smaller trees in the windbreak?
- Which directions do the winds come from?
- From which directions do the strongest winds and storms come from?
- Important to end with this question: Where does the family want to establish a windbreak or transform existing trees into an efficient windbreak?

Activity 3: **Design the windbreak**: In designing the windbreak have and introductory dissuasion covering the following five important design considerations with the farmers

- What is the ideal orientation of a windbreak?
- What happens if the orientation is not perpendicular to the wind?
- What spacing is appropriate for trees in a windbreak?
- What will happen in the trees are too dense?
- How high should a windbreak be?
- How far does a windbreak protect?

- Does the entire windbreak have to be of the same trees?
- What will happen if the windbreak is not uniform?
- How many rows should comprise the windbreak?

Further questions depending on the scenario

The segment already has plants in line	The segment does not have plants in line
▪ Which species are there? ▪ How many individuals per specie? (inventory of all plants) ▪ Which good and services does the family obtain from these plants? ▪ What effects (interactions) do trees have on crops? For example, analyse whether the shade of trees affects the growth and yield of adjacent crops.	▪ Which tree species should be planted? ▪ How many individuals per specie will we need? ▪ Which good and services does family want to obtain from these plants? ▪ What effects (interactions) do trees have on crops? For example, analyse whether the shade of trees affects the growth and yield of adjacent crops.

Design: Using a flipchart and markers, instruct the group to propose a new design or improvement for the windbreak.

- How are the five guidelines described above integrated in the designs?
- What are the expected interactions and management required to minimize negative interactions and maximize positive interactions?

Activity 4: **Windbreak establishment -** Have farmers prepare the site and establish a small windbreak in the selected location of the farm taking into consideration all aspects of species selection, spacing, and interactions between trees and crops.

Conclusion

The effectiveness of a windbreak is dependent upon blending the 5 considerations, 5 agroforestry questions and the analysis of how to manage the possible interactions.

Families must be realistic about what they can do and with what available resources to accomplish the plan for the windbreak.

Daily Summary and Observation Analysis

Reconvene the farmers in a circle at the end of the session. Facilitate the summary by asking questions such as:

- What did you think about the work today?
- What was easy about today's activities?
- What was difficult in today's activities?
- What should the future positive and negative interactions be in the field from the windbreak?
- What are the advantages of working together?
- What costs are involved and how can we reduce costs?

Handouts

Facilitator's Resource

Handout 1: Benefits and Drawbacks of line Plantings and Windbreaks
Handout 2: Line Planting and Windbreak Design
Handout 3: Tree Selection and Future Interactions
Handout 4: Silviculture and Management of Linear Planting

HANDOUT: Facilitator's Resource

Jamaican farms are small with properly defined boundaries, but they frequently have few internal, permanent divisions between crop fields. Line plantings of trees to attain multiple farm objectives (production of timber, fruit, farm demarcation, windbreak, etc.) and can be established along farm boundaries. A windbreak designed to protect a crop field can also provide timber, fruits, habitat for wildlife, a reduction in dust and chemical drift, and an increase in property value. Farmers must learn how to manipulate shading and root competition between line plantings and crops in order to design them correctly.

Definitions

Line planting is a group of plants (shrubs or trees) of one or various species, planted or recruited from natural regeneration, in one or more contiguous, parallel lines, following straight, curve or angle paths, and accomplishing objectives defined by the owners of the farm.

Segment is a portion of the line planting.

Windbreaks are one type of line planting. Windbreaks are strips of trees and/or shrubs planted and maintained to alter wind flow and microclimate, thereby protecting a specific area. A windbreak works by filtering and slowing the wind. Effective windbreaks provide protection from prevailing winds, and can also limit damage from storms. Windbreaks also improve the quality of life around farmsteads, rural residences, and communities.

Interactions refers to the influence (e.g. shading or competition for water or soil nutrients) of one component of the system (e.g. the trees) over the performance of other components of the system (e.g. the crop).

Goods are the tangible products obtained from the farm. For instance, lumber, fruits, honey, medicinal plants, industrial products such as palm oil, and rubber coconut.

Services are things that benefit the farm, the environment and people, but which we cannot touch. Examples include the reduction of soil erosion, the improvement of fertility, and the reduction of greenhouse gases from the atmosphere by carbon sequestration in tree trunks.

HANDOUT 1: Benefits and Drawbacks of Line Plantings and Windbreaks

Potential Benefits and Drawbacks of Windbreaks

Potential Benefits of Windbreaks

- To improve crop quality and yield by protecting crops from wind damage;
- To conserve moisture by reducing evaporation and transpiration;
- To protect from extremes of salt spray or hot, dry winds and dusts;
- To increase property value; and
- To reduce noise levels and wind erosion.

Additional Benefits from Windbreaks

- Provide additional economic products such a fruits, nuts or timber.
- Increase on site resources for farm use such as animal fodder, mulch, food, poles, and firewood.
- To increase the aesthetic value and/or recreational value of the property.
- Provide greater ecological and economic stability through addition of diverse species. to the farm system

Potential Drawbacks of Windbreaks

- A windbreak installed or managed incorrectly can create wind damage rather than prevent it.
- Windbreaks take up space and land that could be used for crop production.
- Windbreaks may compete with crops in the root zone and may also create shading.
- Windbreaks are a long term investment in trees, planning time and installation. The benefits will usually not begin until several years after the installation.
- Windbreaks planned or installed improperly can interfere with access, view planes, power lines and neighbouring borders.

HANDOUT 2: Line Plantings and Windbreak Design

Each windbreak design is unique, depending on objectives of the landowner and local site conditions. In the design of a windbreak six key physical and structural considerations are necessary to consider:

Orientation

Windbreaks are most effective when oriented at right angles (perpendicular) to the prevailing direction of the wind. To allow for changes in wind direction, windbreaks are often planted in multiple directions such as an L, U, or E shape. The ideal windbreak is oriented perpendicular to the prevailing winds and located on the windward side of the land area to be protected.

When orienting the windbreak, avoid placement that may cause future management problems such as interference with utilities or road visibility.

By manipulating these components, an effective windbreak can be designed to meet the landowner's objectives.

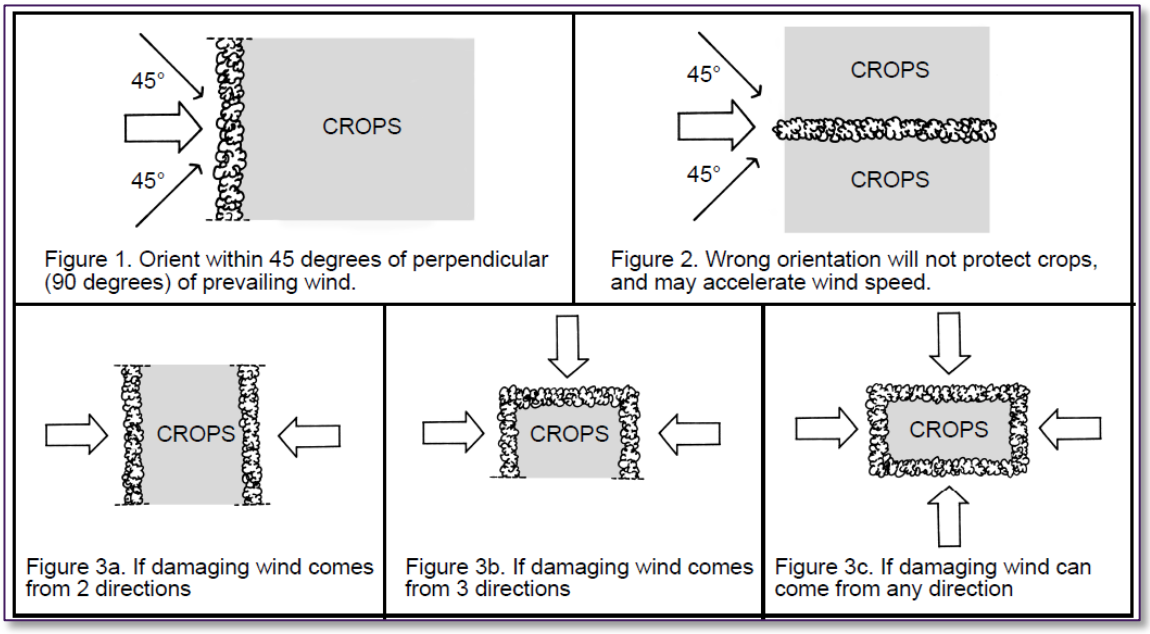


Figure 1. Orient within 45 degrees of perpendicular (90 degrees) of prevailing wind.

Figure 2. Wrong orientation will not protect crops, and may accelerate wind speed.

Figure 3a. If damaging wind comes from 2 directions

Figure 3b. If damaging wind comes from 3 directions

Figure 3c. If damaging wind can come from any direction

Spacing and Density

A windbreak is designed to slow and filter the wind, but not to block it entirely. If a windbreak is too dense it can lead to severe turbulence over the crop area. Ideally, windbreaks are about 20-50% permeable. This can be achieved with the correct spacing of the trees. Spacing within rows should be laid out so when trees in the windbreaks are mature the crowns of the trees will touch or overlap slightly, but not crowd each other. Planting trees too closely can cause early deterioration of windbreaks, especially on dry, un-irrigated sites due to excessive competition for water among trees. Wider spacing may mean additional time for the windbreak to become effective, but will prolong the effective life of the windbreak. Species selection is important and will also affect the density of a windbreak. The density can be managed by the selection of the tree species, the spacing of the trees, and the number of rows in the windbreak.

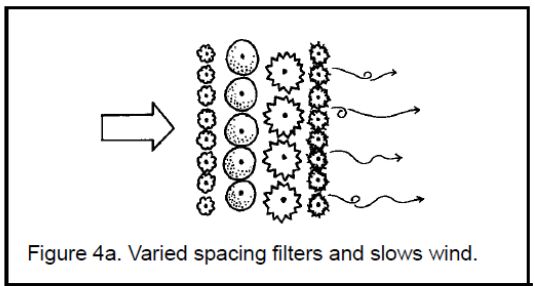


Figure 4a. Varied spacing filters and slows wind.

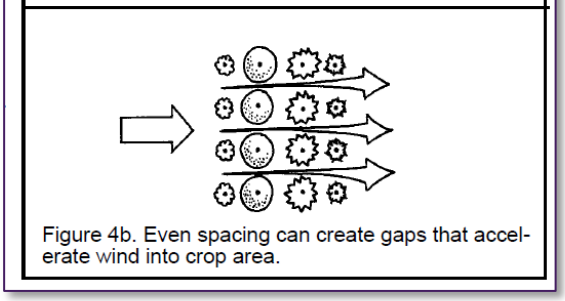


Figure 4b. Even spacing can create gaps that accelerate wind into crop area.

Table: *Spacing guidelines for windbreak design.*

Spacing within row	
Short trees (up to 6 m)	0.6-2 m
Medium trees (6.15 m)	1-3 m
Tall trees (15 m or more)	2-5 m
Spacing between rows	
If adjacent row is made of short trees	1.8-3 m
If adjacent row is medium sized trees	2-5 m
If adjacent row is made of tall trees	2.5-6.2 m

Height

The height of the windbreak, often referred to as H, is an important factor determining how far downwind the protected zone will reach. This value increases as the windbreak matures. Windbreaks reduce wind for a distance from two times (2H) to ten times (10H) the height of the windbreak on the leeward, or downwind, side.

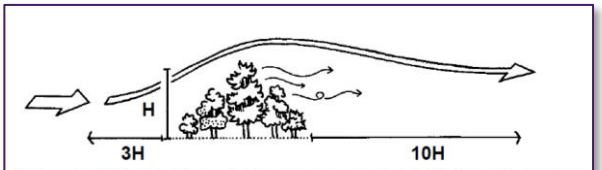


Figure 6a. Windbreak protects crop area to about 10 times the height of the tallest tree in the windbreak.

Measurable reductions can also occur as far away as thirty times the height. For example, a windbreak where the tallest trees are 9 m will protect an area from 18 m to 90 m leeward of the windbreak. On the upwind side of a windbreak, wind speed reductions are measurable for a distance of two to five times the height of the windbreak. Plants will receive the most protection within 7H of the windbreak. If plants are not very wind-sensitive, the protected zone could be considered to extend up to 15H in some cases.

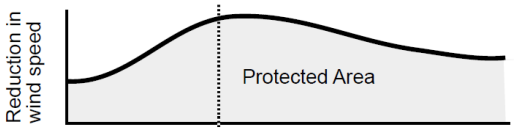


Figure 6b. The reduction in wind speed tapers off as distance from the windbreak increases.

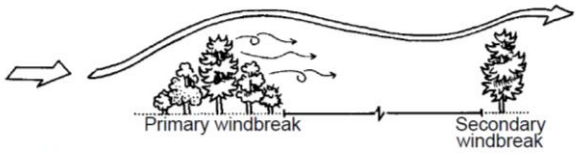


Figure 7. If crop area longer than 10X windbreak height, add secondary wind strips to continue protection.

For larger properties, secondary wind strips may be necessary within the property to adequately protect the entire area.

The height of the windbreak should also be determined by the expected height of the crops. Windbreaks should be taller than the crop plants-ideally at least twice as tall as the crop.

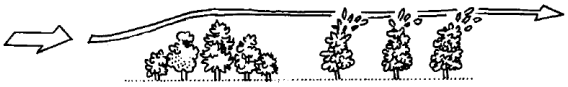
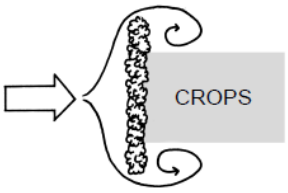


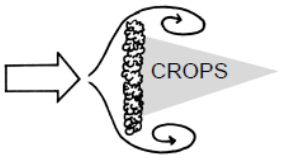
Figure 8. The tallest row of the windbreak must be taller than the crops—ideally 2X taller.

Length



YES

Figure 9. Extensions beyond the crop area provide better protection in a single-leg windbreak when damaging winds come from one direction.



NO

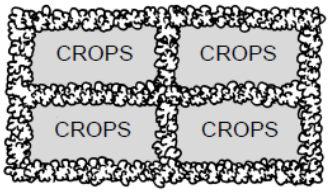
Figure 10. A windbreak that is too short will create turbulence in the crop area.

YES

Figure 11. Additional legs protect more area, and protect from variable wind directions.

YES

Figure 12. A windbreak surrounding the crop area can protect from variable winds.



YES

Figure 13. For large crop areas, secondary wind strips supplement the primary, surrounding windbreak.

The length of the windbreak determines the amount of total area receiving protection. Windbreaks should be designed to prevent damaging wind from coming around the ends. This involves either additional length beyond the area to be protected or additional length that prevents wind from whipping around the end and into the crop area. For best protection, the uninterrupted length of a windbreak should exceed the height by at least 10:1. For example, if the height of the windbreak is 9 m, the windbreak needs to be at least 90 m long to minimize the impact of air turbulence around the end of the windbreak.

Where damaging winds come from several directions, windbreaks surrounding the protected area may be more appropriate. If a windbreak completely surrounds the crop area, crops are protected on all sides. For large crop areas, secondary internal wind strips area necessary to supplement the surrounding windbreak.

Continuity

It is essential to maintain continuity in a windbreak to achieve full effectiveness. Windbreaks should not have any large gaps. Gaps create a funnel effect that concentrates wind flow, increasing wind speed in excess of those in the open field often causing damage downwind from the gap. Replacing trees that die and locating access lanes around the ends of the windbreak can prevent gaps. If roads, lanes, or a large ditch must cross a windbreak, try to make the crossing at an angle to the prevailing wind direction. The goal is for the trees and shrubs to grow together to form a continuous barrier within ten years.

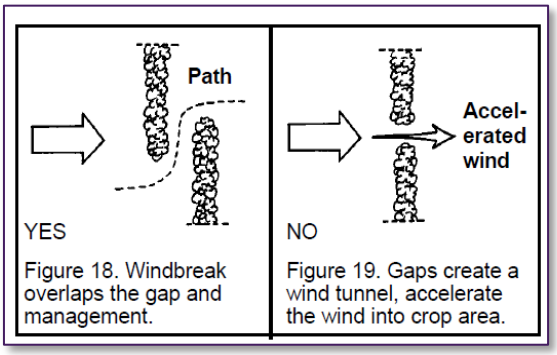


Figure 18. Windbreak overlaps the gap and management.

Figure 19. Gaps create a wind tunnel, accelerate the wind into crop area.

Number of Rows

An effective windbreak requires at least two rows of trees. Tall trees protect a larger area of the field, but the usually have high canopies which can create an understory gap. Smaller trees with lower canopies are planted in an additional row to fill this gap.

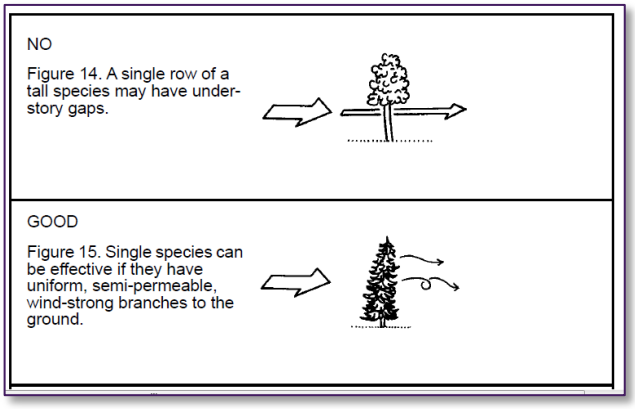


Figure 14. A single row of a tall species may have under-story gaps.

Figure 15. Single species can be effective if they have uniform, semi-permeable, wind-strong branches to the ground.

A single row windbreak can be effective if the specie used has uniform, semipermeable, wind-strong branches to the ground. However, there are a number of drawbacks to single-row windbreaks. Desirable species that fit this description are limited. However, they have the advantage of taking up less space on the property.

Multiple-row windbreaks consist of two or more rows and of several kinds of species. These windbreaks use more space than single row windbreaks, but there are a number of advantages, including:

- Greater flexibility in species selection, layout and management, while maintaining the necessary structure.
- Reduced maintenance burden because multiple rows help prevent gap problems.
- Harvest of timber or other products without compromising windbreak function.
- Increased opportunity for secondary products (several species).
- Decreased risk of loss of investment in the windbreak through pest or disease problems that attack single species.

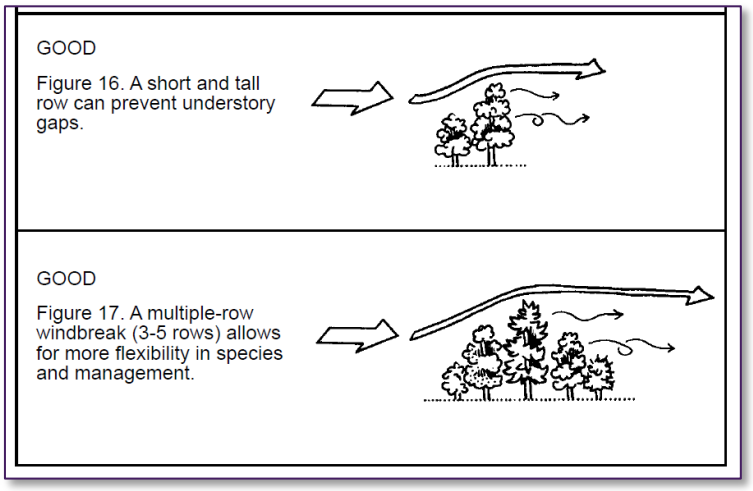
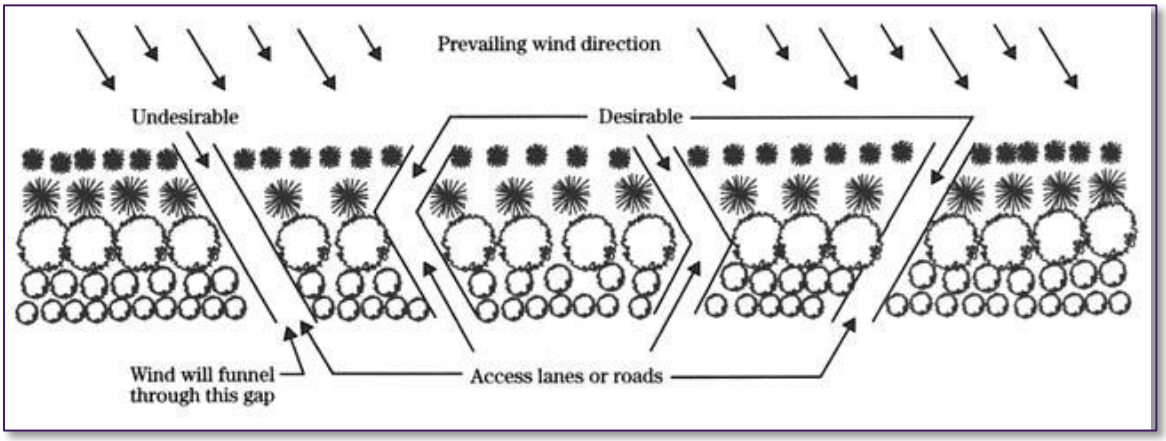


Figure 16. A short and tall row can prevent understory gaps.

Figure 17. A multiple-row windbreak (3-5 rows) allows for more flexibility in species and management.



HANDOUT 3: Tree Selection and Future Interactions

Tree Selection for Linear Planting and Windbreaks

For tree selections we need to take into account the following criteria:

- **Valuable trees:** Select trees with good quality if our interest is wood production or trees with good options for commercialization or products demand.
- **Fast growing species:** Rapid growth will result in sooner reaping of benefits.
- **Availability of seed:** It is strongly recommended to use superior genetic material that produces strong, healthy plants with good shape.
- **Susceptibility pest and diseases:** It is not recommended to use species with high susceptibility to pest and diseases.
- **Use of trees with previous success in reforestation program:** Use trees that have shown to grow well when planted in the area.
- **Open and low dense canopy:** to minimize light competition with companion crops, it is recommended to use species with open, light canopies.
- **Little management demand:** Select tree species that are aggressive or rustic and have the capacity to survive and grow fast with low inputs and management.

Interactions and Its Management

The main interactions between trees and crops in a lineal planting and windbreaks are root competition and shade.

- Shading may reduce crop yield. Shade on crops can be reduced with a property tree selection, density, arrangement and pruning.
- Competition for water and nutrients between the root system of trees and crops should be minimized. We should select tree species with a deep root systems rather than a strong lateral root system. Lateral roots are shallow and compete with crops for resources (nutrients, water). It is therefore necessary to choose trees that show deep lateral root growth.
- Just as they may be habitat for birds and beneficial insects, trees can also be habitat for pests. Avoid planting trees that are known to host pest or diseases harmful to the crops.

HANDOUT 4: Silviculture and Management of Linear Planting

For the establishment and management of linear plantings, is necessary to take into consideration the following silvicultural criteria:

- **Site preparation:** It is necessary to clean up the site from weeds, especially grasses and lianas that will affect tree growth in the first year if not managed correctly. If trees are planted in a bush land then it is necessary to clear a strip 6 meters wide in the bush to plant the trees.

- **Spacing:** The spacing for a linear planting depends of the purpose of the plantation. For example, if the main objective of the linear planting is to produce firewood or charcoal, plant the trees at closed spacing (2 meters between trees). However if the purpose is to obtain wood for sawmill, the spacing will have to be more than 3 meters between trees and complement with thinning.

- **Planting:** The correct time to plant the trees is in the beginning of the rainy season; this way, the trees will survive the following dry season without irrigation.

- **Management of timber trees in linear plantings:**

  - ✓ **Protection against fire:** It is important to desirable before dry season start, to make a firewall round and eliminate organic material of easy combustion to avoid losses by fire.

  - ✓ **Weeding:** It is recommended to facilitate initial growth and avoid that grasses or other weeds suffocate the trees.

  - ✓ **Pruning:** Trees in linear plantings develop more branches than in a compact plantation, because of reduced lateral competition with other trees. For that reason it is necessary to prune the trees early in their lives in order to improve the quality of the wood at the end of the cycle. Never prune off more than 30% of the crown of the tree.

  - ✓ **Thinning:** Every tree species needs a minimal spacing to growth well. Thinning is necessary when the branches of neighbouring trees overlap. Early thinning is the recommended practice.

Module 8: Tropical Home Gardens

Objectives

- To use vertical and horizontal mapping as a tool to introduce farmers to objectively assess an existing home garden.

- To enable farmers to use the assessment finding to make recommendations and design a strategy that maximizes productivity from the land and meets the farm families objectives.

Supplies

- A guide for diagnosing home gardens;
- Flip charts and markers;
- Copies of the forms; and
- Sticks for marking planning spots.

Preparation

Before this meeting, work with the farmers to select a family with a home garden where the session can occur. The selected family should be willing to participate in the AFFS session and desire to improve or expand their home garden.

Venue

Farm with a home garden.

Total Time

Approximately 4 hours

Activities

1. **Introductory activities:** Begin the session with an explanation of the principal concepts (definitions) that will be used during the session.

    a. Use the introduction and definitions (see facilitator's resource) to provide farmers with an overview of the topic of home gardens (HG).

2. **Why should we to improve home gardens?** Have the participants share ideas and their expectations on why and how to improve home gardens. Several potential benefits should be presented.

a. Write the benefits presented by the group on flip charts.

b. Use **Form A: *Products from home gardens*** to list the current and desired home garden products.

REFERENCE FOR DISCUSSION

Use the lists of characteristics and advantages in **Handout 1: General Characteristics and Benefits of Home gardens** to help inform the discussion. The result of this brainstorming activity should be that everyone's attention and interest is elevated as they begin to dream of the possibilities

3. **Discover the family objectives:** Have the AFFS participants interview the family about their objectives and future vision for their home garden. This includes determining:

a. What they have harvested in the past?
b. What they currently harvest from it?
c. What they hope to obtain in the future?

Have the group write this information on a flipchart. From the group determine why they think it is worth taking the time to analyse and improve their HG. Conclude this activity by stating that in order to achieve the objectives, the first fundamental task is to diagnose the HG by walking through it and analysing it systematically.

NOTE

In addition to considering what they might plant, also encourage the participants to consider opportunities for integrating livestock or growing forage. It is also important to know if the family wants to expand the current HG in the same place or other places on the farm, or if the family is only willing to improve the current HG (without expanding).

As part of the brainstorming and discussion on development plans for the family's home garden, use the descriptions of types of home gardens in Handout 2: Structure of Home Gardens to help the family decide which type they would like their home garden to develop into.

4. **Agroforestry diagnosis of the home garden:** Have all the AFFS small groups go to the home garden to do inventories and describe the characteristics of the present situation. They should draw sketches of the horizontal and vertical distribution of trees in order to assess and understand the structure of the Home garden.

a. **Explore the home garden:** Ask the farmers to walk around the plot, and afterwards engage them in discussion using these five agroforestry questions as a guide:

- Where are the woody perennials located in the farm?
- Which species of woody perennials grow in the parcel or in a line?
- How many plants of each woody perennial species are there in the parcel or line?

- Which goods (products) or services does the farmer obtain from these woody plants?

- Which favourable or unfavourable interactions do these woody perennials have with other crops or animals in the HG?

b. Instruct the farmers to use **Form B: List the current plant species and their goods and services in the Home garden** to count how many plants there are per species. While registering the information in the form, be sure to ask the family about the practices that they do to manage the plants.

- What are the positive and negative interactions in the home garden?

- Does the family have unproductive trees well-identified? What do they do want to do with them? Is the family willing to replace them?

c. Mapping the home garden: Instruct the farmers that in order to assess the structure of the home garden, they should make a horizontal and vertical sketch (two drawings) of the home garden. The horizontal sketch is a bird's-eye-view. The vertical sketch is a cross-section looking from the side. Instruct them to apply as much detail as possible such as the height of trees, the width of the crowns and the species present.

5. ***Further diversification of the HG:*** Following the diagnosis, the facilitator will stimulate discussion in the groups to analyse the current and possible interactions. Instruct the farmers to complete **Handout 3: Menu of Local and Exotic Species with Potential to be Introduced in Home gardens**

> **NOTE**
>
> It is helpful for the facilitator to have pictures of trees and descriptions (height, canopy width, foliage density, potential yields, and nutrients) to assist with brainstorming. With this information the facilitator, technicians and families can select the most suitable species according to the conditions of soil, weather, market access, potential income, and other benefits for domestic consumption. Women are critical in this consultation because they are frequently the ones who manage home gardens.

6. Have each group present their recommendation to the farm family on how they can improve their home garden. They will present a small menu of options to the family who discusses the options and attempts to make a final decision on what they would like to do to improve their home garden.

> **NOTE**
>
> Discuss all the suggestions with the family members to analyse what knowledge and skills the family has and needs to implement the innovation. The management that each family provides to their home garden (based on family needs, preferences, economic resources and knowledge) will be the main factor in determining different intensities of production in this agroforestry ecosystem.
>
> It is also important to select species that mature or bear fruit or other products at varying times of the year so as to diversity the sources and timing of harvest and to avoid excessive work load at any one time

7. Where to plant new trees: Once the potential species have been selected, designate the areas in the sketches where the species can be planted. Use **Handout**

4: Managing Interactions as a guide for discussion the future interactions in the home gardens where new trees will be cultivated.

a. Have participants mark the places on the ground by inserting sticks in the planting locations.

> **NOTE** If one tree will be replaced for another, consider which is the most appropriate replacement to avoid negative interactions (shade, competence, etc.). If the trees are destined to expand the home garden, then it will be necessary to plan the arrangements carefully (horizontal distributions, distances among plants, etc.)

b. Have the group brainstorm and develop a criteria for the location and arrangement of trees. For example, coconuts are not good near to the house because it implies danger (fruits could fall down on people), mangos could attract flies and get the floor dirty. Trees that need irrigation or special fertilization must be near to the house to facilitate the work.

> **NOTE** If trees need to be pruned, use Handout 5: Silviculture as a guide.
>
> Once the family – with the farmers as advisors - decides how many trees per specie are needed, these numbers should be captured in Form C: List of the desired plants for the Home garden.

Conclusion

- Types of home gardens and their management are based on family needs, preferences, economic resources and knowledge.

- The presented methodology can simultaneously help farmers to enhance household food security and to increase the adaptive capacity of their homesteads to climate change.

Daily Summary and Observation Analysis

Reconvene the farmers in a circle at the end of the session. Facilitate the daily summary by asking questions such as:

- What did you think about the work today?
- What was easy about today's activities?
- What was difficult in today's activities?
- What observations do you have?
- What are the advantages of working together?
- What costs are involved and how can we decrease costs?

Handouts

Facilitator's Resource

Handout 1: General Characteristics and Benefits from HOME gardens

Handout 2: Structure of Home Gardens
Handout 3: Menu of Local and Exotic Species
Handout 4: Managing Interactions
Handout 5: Silviculture in Home Gardens
Handout 6: Forms
    A. Products
    B. Potential Species
    C. Desired Plants

HANDOUT: Facilitator's Resource

Home gardening has a long tradition in many tropical countries. Tropical home gardens consist of an assemblage of plants, which may include trees, shrubs, vines, and herbaceous plants all growing in or adjacent to a homestead or home compound. These gardens are planted and maintained by members of the household and their products are intended primarily for household consumption. Home gardens also have considerable ornamental value, and they provide shade for people and animals. The word "home garden" has been used rather loosely to describe diverse practices, from growing vegetables behind houses to complex multi-storied systems. It is used here to refer to intimate associations of multipurpose trees and shrubs with annual and perennial crops and livestock.

Home gardens are central to the livelihood strategy of the rural families in Jamaica. Home gardens provide a sizeable fraction of the food (quantity and quality) consumed by the family. Home gardens can also offer opportunities for small-scale production and sale of manufactured products (e.g. jellies, dried fruit, etc.). Home gardens in Jamaican farms are usually well-diversified but farmers are very interested in diversifying and expanding them further. We aim to improve the quality of existing fruit stocks by training farmers to select and propagate superior genotype. High quality exotic species could be promoted for export markets, as well as high-end national consumers and tourists.

Definitions

Home Gardens (HG) refers to intimate, multi-story combinations of various trees and crops, sometimes in association with domestic animals, around homesteads.

Interactions refer to the influence of one component of the system over the performance of other components of the system. Examples of interactions are the influence of shade on cacao or coffee plants from surrounding and competition between plants and trees for water and nutrients.

Goods or **products** are things that home gardens provide that we can touch with our hands. Common HG products include food, fodder, lumber and firewood.

Services refer to things that benefit the farm, the environment and people but which we cannot touch. Examples of services include: the reduction of wind, dust, and soil erosion; the improvement of fertility, and the reduction of greenhouse gases from the atmosphere by carbon sequestration in tree trunks.

HANDOUT 1: General Characteristics and Benefits from Home Gardens

General Characteristics of the Home Gardens

- Food production is the primary function of most home gardens, the vast majority of them being subsistence production systems. The nature of woody perennials varies, depending on environmental and ecological factors. In general, most woody components produce fruits or other types of food in addition to other outputs such as fuelwood, and timber.

- It is an integrated system of production around the homestead. Several species of plants are cultivated and maintained by the family members of the households primarily for their own consumption.

- Mixing of different compatible species is commonly practiced to maximize the utilization of spatial (intensive use of ground and vertical space) and temporal (staggered planting and harvesting) dimensions of the home gardens.

- Home garden structures generally consist of multi-layered arrangement of plant species. Each canopy of the garden has a specific place and function.

- The structure and species composition of home gardens are influenced by agroecology, socio-cultural practices, economic status of the family and market conditions.

- Home gardens are dynamic production systems – its structure and species composition may change over time based on the needs of the family and, at the same time, new plant species that are continuously introduced.

- Home gardens are maintained to meet multiple objectives and needs of the families, such as food, spices, medicines, livestock fodder and ornamental purposes.

- Families with home gardens located next to roads should consider emphasizing the planting of species whose products can sell in the high traffic areas.

General Benefits from Home Gardens

- Home gardens are an important source of quality food and nutrition, especially for rural families. Home gardens are important contributors to the food security and livelihoods of farming communities.

- Home gardens provide a safety net for households when food is scarce. These gardens are not only important sources of food, fodder, fuel, medicines, spices, herbs, flowers, construction materials and income, but they are also important for the

in situ conservation of a wide range of unique genetic resources for food and agriculture.

- The plant diversity in home gardens is characterized predominantly by multi-purpose plants in various vegetation layers. This allows for good utilization of environmental factors like water, nutrients and sunlight.

- The plant diversity in home gardens serves to enrich the biological diversity; moreover, these systems do not depend on high energy inputs such as chemical fertilizers, fuel-powered machinery or pesticides.

- The diversified food products provide a substantial proportion of nutritive and energy requirements of the local diet. Moreover, the species diversity and varying production cycles of the different components ensure continuous production throughout the year from the home garden.

- Home gardens are considered as a place to relax, socialize, and enjoy shade and where children can play safely.

Home Gardens Compared with Other Cropping Systems

The following are some of the economic, social and/or cultural foundations of home gardening in comparison with other cropping system components under similar situations:

- Low capital requirements and labour costs – suitable for resource poor and small-holder farming situations.

- Better utilization of resources, greater efficiency of labour, even distribution of labour inputs and more efficient management.

- Diversified range of products from a given area and increased value of outputs

- Increased self-sufficiency and reduced risk to income from climatic, biological or market impacts on particular crops/products.

- Higher income with increased stability, greater equity and improved standards of living.

- Better use of under-utilized land, labour or capital, besides creating capital stocks to meet intermittent costs or unforeseen contingencies.

- Enhanced food and nutritional security and an ability to meet the food, fuel, fodder, and timber requirements of the society.

- Increased fulfillment of social and cultural needs through sharing or exchange of produce and recreational opportunities.

- Better preservation of indigenous knowledge.

Types of Home Gardens

In home gardens studied by ethnobotanists, the gardeners usually grow fruit, vegetables, herbs, and ornamental plants, primarily for subsistence and for their own enjoyment. But the uses of home gardens vary; some are used for the commercial production of vegetables while others have only lawn and ornamental species. There can be several types of Home gardens according to the objectives of the families (Table 1).

Table 1: Types of Home gardens

Homegarden type	*Characteristics*
Survival gardens	Gardens form single component farming system of otherwise landless rural people
	Combined production of staple food crops and complementary crops
Subsistence gardens	Part of multi-component farming system in conjunction with permanent or shifting field production
	Complementary system to open-field staple food cultivation systems
	Provision of daily supply of vegetables, herbs, spices and fruits for household needs and occasional sale
Market gardens	Specialized farming system or part of multi-component farming system
	Cultivation of cash crops with possible complementary production of household products
Budget gardens	Gardens of households with economic bases in rural or urban employment; family needs are mostly purchased from the market
	Cultivation of 'hobby' products for household consumption and ornamentals

Source: Adapted from Niñez (1984).

HANDOUT 2: Structure of Home Gardens

Home gardens can be described vertically and horizontally in order to understand the distribution of plant species.

Vertically, in spite of the very small average size of the management units, home gardens are characterized by high species diversity and usually 3-4 vertical canopy strata. This tight space results in intimate plant associations. The combination of trees and other in a layered canopy configuration is the most obvious characteristics of all home gardens. In general terms, all home gardens consist of an herbaceous layer near the ground, a tree layer at upper levels, and intermediate layers in between. The lower layer can usually be partitioned into two, with the lowermost (less than 1 m height) dominated by different vegetable and medicinal plants, and the second layer (1-3 m height) being composed of food plants such as cassava, banana, papaya, and yam. The upper tree layer can also be divided in two, consisting of emergent, fully grown timber and fruit trees occupying the uppermost layer of over 25 m height, and medium-sized trees of 10-20 m occupying the next lower layer. The intermediate layer of 3-10 m height is dominated by various fruit trees, some of which would continue to grow taller. This layered structure is never static; the pool of replacement species results in a productive structure which is always dynamic while the overall structure and function of the system are maintained. An example of a vertical arrangement is presented in Figure 1.

Horizontally, home gardens usually follow regular, distorted, randomized or patchy distribution of the plants inside the plots, in many cases plant distribution in home gardens is a combination of these patterns. Families could adopt any of those patterns according to their objectives and resources, and the particular desired ways to manage the home garden. Pictures of horizontal arrangements are presented in Figure 2.

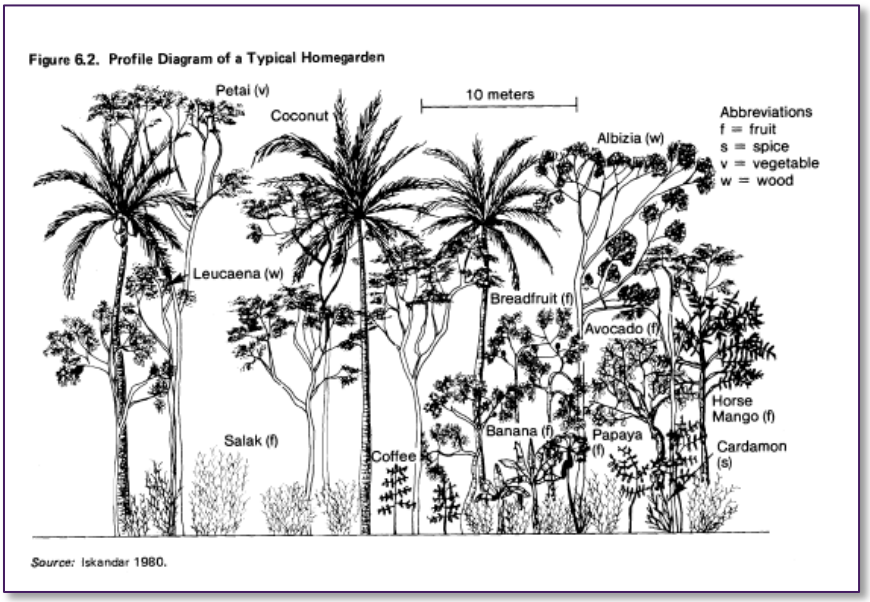


***Figure 1**: An example of vertical arrangement of complex home gardens in the tropics (Iskandar 1990).*

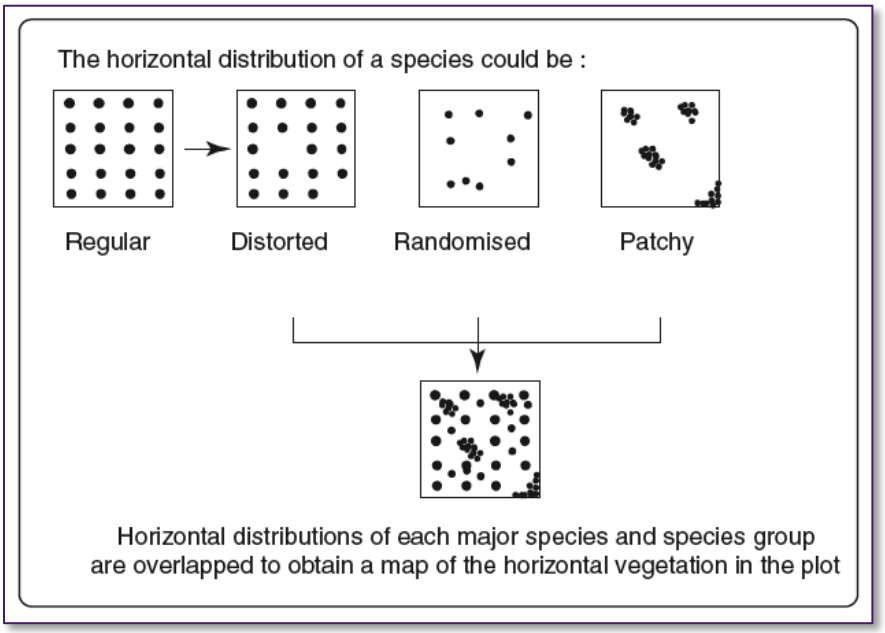


***Figure 2**: Horizontal arrangement of home gardens in the tropics (Lamanda et al 2006)*

HANDOUT 3: Menu of Local and Exotic Species with Potential to be Introduced in Home Gardens

Potential Fruit Species

Fruit Species	Height of the tree	Canopy width	Foliage density	Potential yields	Nutrients for the family
Litchi (*Litchi sinensis*)					
Arazá (*Eugenia stipitata*)					
Cas (*Psidium friedrichtalianum*)					
Biribá (*Rollinia mucosa*)					
Abiu (*Pouteria cainito*)					
Sapote (*Pouteria mammosum*)					
Canistel (*Pouteria campechianum*)					
Asaí (*Euterpe oleracea*)					
Rambután (*Nephelium lappaceum*)					
Salak (*Salacca salaca*)					
Red, Yellow and White varieties of Pitahayas (*Hylocereus* spp.)					
Grumichamas (*Eugenia brasiliensis*)					
Achachairú (*Rheedia* spp.)					
Jaboticabas (*Myrciaria cauliflora*)					

HANDOUT 4: Managing Interactions

The main interactions among plants would be in terms of shade and competition for space, water and nutrient, because home gardens are generally in small lands.

- It is important that medium height trees with dense crowns (such as avocados) do not affect other plants or trees with their shade. For example, trees like citrus or plants like pineapple should be in places where an excessive shade of other trees does not affect them.

- The distance between trees should be at least the minimum to avoid the overlap of their crowns when trees will be adults, either horizontally and vertically.

- The shade of a tree generally will move straight from west to east, knowing that, other trees, shrubs or plants which requires sun light all the day should not be established in that route.

- On the other hand, trees or shrubs which tolerates or need shade (e.g. cocoa, coffee) could be established near other bigger trees.

- If one tree is already established and providing excessive shade in a home garden, this tree should be removed, replaced or pruned to reduce the density of the crown.

- The root system of the tree is another important factor. If the roots of a plant are abundant and superficial (such as palms) then, then they will compete more for space, nutrients and water.

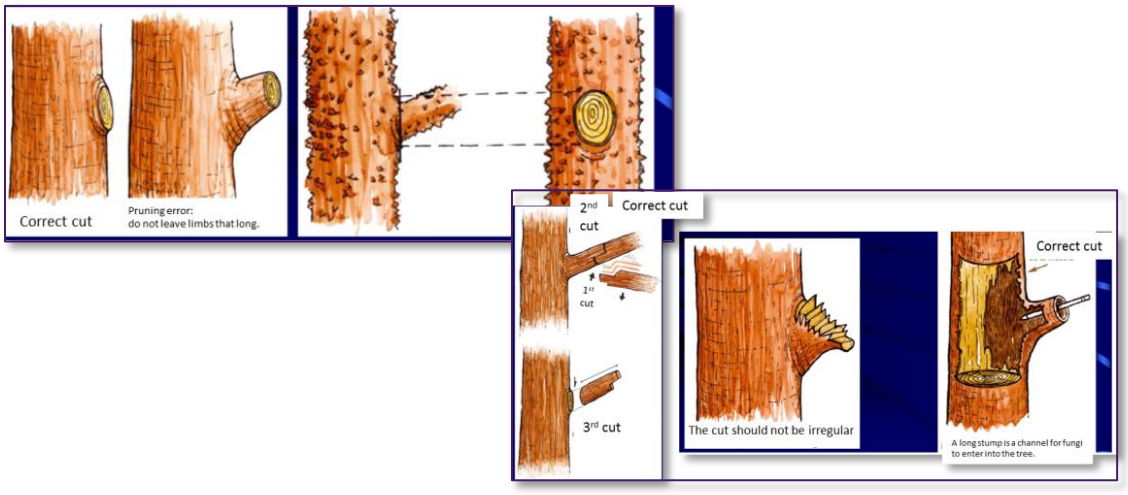
- Although the farmer should try to maximize the productivity of the home garden by planting several plants, it is still important to respect a minimum distances of spacing so as to not hinder their growth. For example if a tree will be maintained with a crown of 3 meters, then the distance between trees must be at least 3x3m. In that way the crowns will not overlap and the competition among roots will be low.

HANDOUT 5: Silviculture in Home Gardens

- Tree management and protection can be different in every home garden. The management can be divided into three main groups: cultivated, protected or spared.

  1. When plants are cultivated, they are sown or planted by the owner.
  2. Plants are protected or encouraged when they are transplanted from other zones outside the garden or when they grow spontaneously in the garden. The owner decides to protect or encourage the plant by supporting or protecting volunteer seedlings, for example, by supporting it or attaching the plant to a solid structure, or by putting stones around the plant.
  3. Spared plants are plants that spontaneously grow in the garden and are not removed.

- From the early growing stages of the woody perennials it is important to prune. During the first three years a formation pruning will be needed at least twice a year in order to form the crown and to avoid overlap with neighbouring trees
- During the first year it could be necessary to use sticks as tutors for some trees in order to encourage a correct growing in height
- During the formation of the tree the farmer must decide the architecture and shape aspects of the crown which are suitable for their objectives and characteristics. For example, a citrus tree could be pruned in such a manner that the crown starts at 1 meter from the floor, which means that all the branches below that height must be cut. Another example is that if a narrow crown is desired then the pruning should form the crown in a manner that the crown will be taller rather than wider
- During maturity, trees will need maintenance pruning once a year in order to maintain the width and the height of the tree
- It is important to cut the branches close to the trunk to encourage a quick healing and to avoid the rooting of internal tissues. When the branches are large and coarse the cut must be in several steps. See the following pictures:



HANDOUT 6: Forms

FORM A - Products from Home Garden

CURRENT			DESIRED (FUTURE)		
Fruits and other edible parts	**Medicinal**	**Materials (handcrafts, etc.)**	**Fruits and other edible parts**	**Medicinal**	**Materials (handcrafts, etc.)**

Family wants to improve and expand the HG? Yes or NO
Family wants only to improve the HG? Yes or NO

FORM B - List the Current Plant Species and their Goods and Services in the Home Garden

Name of the Plant	Number of Plants	Goods and Services it Provides	Months of the year when the plant produces	Height of the crowns	Width of the crowns	Crown sparse or dense?	Practices for plant management

FORM C - List of the Desired New Plants for the Home Garden

Name of the Plant	Number of Plants	Is it better to plant by seeds or by seedlings?	Where to get the seeds or the seedlings	When is the best time to plant?

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Module 9: Fodder Banks

Objectives

- To design and manage multipurpose fodder banks in small spaces in the farm;
- To analyse a families' needs to inform fodder bank design;
- To design a fodder bank with strategic species selection and proper spacing; and
- To establish a fodder lot at a homestead.

Supplies

- A guide for diagnosing the needs for fodder banks;
- Flip charts and markers; and
- Sticks.

Preparation

Identify a family who has small or big animals (at least several goats, pigs and poultry) and who is willing to establish a fodder bank in their farm. The minimum space necessary to prepare a small fodder bank is approximately 10 x 10 meters. It will be additionally beneficial if the practice location also has fodder banks or another silvopastoral system such as live fences.

Venue

A farm where the family is willing to establish a fodder bank.

Total Time

Approximately 5 hours

GROUP EXERCISES

Activity 1: Facilitate a Discussion on What is a Fodder Bank?

Farmers in Jamaica usually have pigs, poultry, goats, and other ruminants as a source of food for the family or eventually for sale. Animals generally are kept confined (tethered or stall fed) to avoid conflicts with neighbours. In these conditions nutritional constraints may occur since animals are kept away from cropland, which is why farmers feed animals with concentrated feedstuff. Another way to produce feed for domestic animals are fodder banks using fodder trees and/or shrubs. Fodder banks could be planted and managed in the farms to provide part of the protein needed by the animals, therefore,

this agroforestry innovation has the potential to reduce the purchase of concentrated feed stuff, meaning more saving for the family, and if the right fodder species are used, the quality and production of meat and milk will be improved. The facilitator will engage the participants in a discussion using the questions below as a guide.

- What is a fodder bank?
- Why should we establish fodder banks?
- What are the family's livestock with livestock?
- How much land and fodder does the family need?
- Where on the farm can fodder banks be grown?
- Which tree species are good fodder species?
- What are the interactions between the fodder species and the surrounding farm?

NOTE

Fodder banks: a mix of several arboreal species and subsistence crops planted in high densities (above 10,000 plants/ha) in order to obtain green protein fodder (leaves and green branches and stalks) to feed livestock.

Activity 2: Diagnostic and Family Objectives for the Animals in the Farm

As in all the agroforestry innovations in the farmer field school, first is necessary to perform a diagnostic and then the recommendations for design and management. Instruct the farmers to use the Form in Handout 1 to interview the family and determine the current and future needs for livestock.

- How many animals does the family currently have?
- What products are obtained from them?
- What crops, foliage and concentrated stuff do they use to feed the animals?
- What animals and products would the family like to obtain?
- Do they already have an idea of what they would like to grow as sources of fodder?
- How much land for the fodder bank will be needed?
- How much fodder can the fodder bank produce?
- Where on the farm is there space for a fodder bank?
- What skills and equipment will the family need to have to manage the fodder bank?

NOTE

After establishing a common understanding of fodder banks and their benefits, the famers align the benefits of fodder banks with the livestock-related goals of the family, ultimately designing and – if timing is appropriate – establishing a fodder bank for the family.

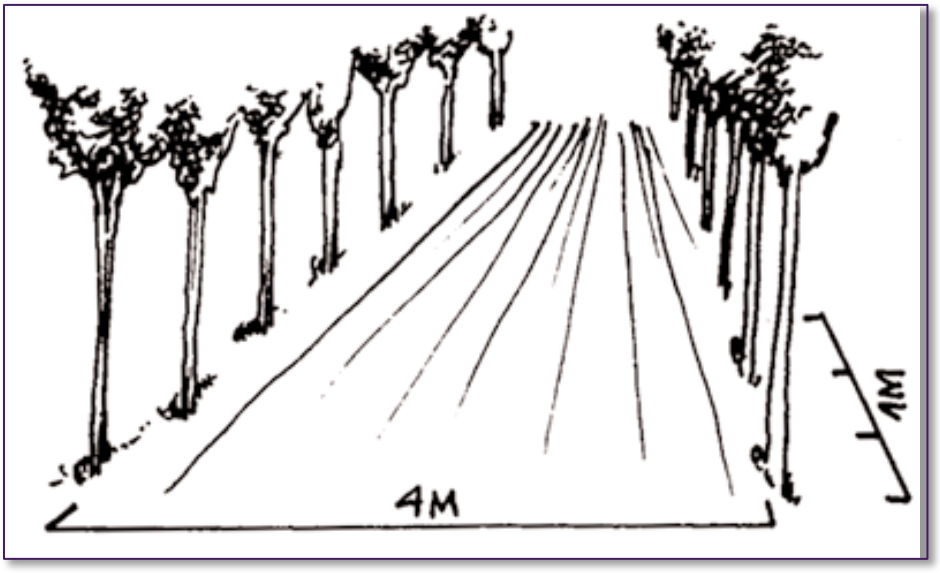
Activity 3: Draw a Sketch of the Intended Fodder Bank Design

Once the farmers and family have decided the places where fodder banks can be established, the next step is to select the species and design the spatial arrangements.

- Do we want to grow one type of fodder species or multiple species?
- Do we want to grow only trees in the fodder bank or are there shrubs and grasses to be included?
- What is the best spacing among the species we would like to plant?
- Taking into account both the height and crown of the species selected and the sun and shading on the identified location, what orientation is best orientation?
- What are the possible interactions in the future between the new fodder bank and the rest of the farm?
- What are the negative interactions that may arise, and how can they be addressed?

Activity 4: Practice Establishment of a Fodder Bank

Once the design has been mapped and finalized, the group must practice the establishment of the fodder bank. According to the type of shrubs and trees that they want to establish, instruct the farmers to use sticks to mark the places with correct spacing where seedlings will be planted. If there are seeds or seedlings available, it would be ideal to allow farmers to plant during the session. Otherwise the rows can be marked and the planting can occur as an assignment for farmers at a later date.



Daily Summary and Observation Analysis

Reconvene the farmers in a circle at the end of the session. Facilitate the daily summary by asking questions such as:

- What did you think about the work today?
- What was easy about today's activities?
- What was difficult in today's activities?
- What observations do you have?
- What are the advantages of working together?
- What costs are involved and how can we decrease costs?

REFERENCE FOR DISCUSSION

The objectives of the family for their domestic animals, availability and characteristics of the land for fodder banks are determinant factors for the design of fodder banks. The comprehension of the interactions and how to manage them is a key factor for the success of the fodder bank. Families must be realistic about what they can do and with what available resources to accomplish the plan to grow a fodder bank.

It is important to consider initial economic and labour efforts to establish a fodder bank. To ensure families are able to be successful in establishing forage lots, consider the establishment costs and cost savings from not buying concentrated animal feed to have a clear projection of the economic situation.

Handouts

Handout 1: Form to Diagnosis the Current and Desirable Benefits/Products from Farm Animals
Handout 2: Definition and Technical Notes
Handout 3: Key Questions to Decide the Fodder Bank Objectives and Design
Handout 4: General Recommendation for Fodder Bank Design and Management
Handout 5: Interactions and its Management
Handout 6: Silviculture (Management of Trees)

HANDOUT 1: Form to Diagnosis the Current and Desirable Benefits/Products from Farm Animals

CURRENT			DESIRED (FUTURE)		
Animals (number and type)	**Products obtained from them**	**What kind of food is used to feed animals?**	**Animals (number and type)**	**Products obtained from them**	**What kind of food is used to feed animals?**

HANDOUT 2: Definition and Technical Notes

Fodder trees are highly nutritious, easy to grow and, by fixing atmospheric nitrogen, improve soil fertility. They are relatively easy to manage. Fodder trees do not compete with food crops. They can be intercropped and, once mature, can be fed to livestock (dairy cows and goats) for up to 20 years.

Fodder trees can be harvested year-round, even providing fodder during the dry season. The trees also provide: fuel wood; stakes for supporting beans and tomatoes, bananas, climbing beans and their flowers; and forage for bees for honey production. In addition, planting forage lots on field contours helps prevent soil erosion.

Why Grow Fodder Banks

Fodder trees and shrubs are highly nutritious, easy to grow and, by fixing atmospheric nitrogen, improve soil fertility. Relatively easy to manage, fodder trees do not compete with food crops, can be intercropped and, once mature, can be fed to livestock (dairy cows and goats) for up to 20 years. Fodder can be harvested year-round, providing fodder even during the dry season. The trees could also provide fuelwood, stakes for supporting tomatoes, bananas and climbing beans, and their flowers provide forage to the bees for honey production. Fodder banks have the potential to reduce the purchase of concentrated feed stuff, meaning more saving for the family.

Technical Notes

- To feed five small animals (such as goats or sheep) throughout the year a small area of 10 m x 20 m for a fodder bank could be enough.
- On small farms, families can plant trees such as *Acacia albida* or *Gliricidia* to serve as **living fences to separate lands** and to protect it from animals or to keep the animals inside. Plant the fence from stem cuttings (*Gliricidia*) placed very close to each other (about 50 cm) or farther if barbed wire will be used among living fence posts.
- For small animals like goats, the best combination could be trees and shrubs.
- If the area for the fodder bank is small and you have several animals to feed, then the spacing between shrubs must be tight. Threes could be planted in rows (alley cropping), with as short spaces between rows as possible. Due to the small area and spacing for sure you will have to cut the foliage to feed the animals in other places. That is why is better if you have the fodder bank closer to the house, to save time and effort to bring the fodder.
- If you have a big area for a fodder bank or you can have several fodder banks in different places, then the spaces between shrubs and tree rows could be larger. In that cases it could be possible to let your animals (cattle, sheep, goats) browse directly in the fodder bank, if the species are not too tall.
- If you have cows and a large area for a fodder bank, you can combine trees, shrubs and grasses, designing wide alleys for grasses with two or more lines of shrubs and trees to separate the alleys.

HANDOUT 3: Key Questions to Decide the Fodder Bank Objectives and Design

The following 7 questions may help you to decide your fodder agroforestry system objectives:

1. Do you have a fodder shortage at a particular time of year?

2. How long does this period last?

3. How often do you expect an *atypical* shortfall in a ten year period?

4. Do overly wet rainy seasons or abnormally long droughts impact what forage is available?

5. Is your fodder shortage due to the quantity of feed or its quality?

6. Is it sufficient to just maintain your animals during the period of shortage, or are you expecting them to grow or gain weight?

7. Is your aim to save money through your fodder project?

If the objective of the fodder bank is protein supplement, there are some considerations for the design and selection of trees and shrubs for fodder banks:

- High protein leaves, seeds or seed pods;
- Rich nutrient pods or fruit; and
- Easy and cheap to harvest.

Otherwise, it is more practical to make better use of existing forage resources. Possibilities for supplementing the forage supply of livestock include:

- **Intercrop or undersow legumes.** These crops retain their nutritive value into the dry season. Examples of herbaceous legume that are valuable for fodder include *Lablab, Stylosanthes*, *Desmodium*, *Mucuna,* and *Centrosema.*

- **Intercrop shrubs and trees.** Many palatable trees (such as *Acacia* and *Bauhinia* spp.) retain their leaves for some or all of the dry season and so can be lopped for fodder. Naturally growing trees can be managed for the same purpose. The pods of many trees also provide abundant, high quality fodder during the dry season (e.g., *Acacia tortilis, Dichrostachys cinerea, Faidherbia albida, Piliostigma thonningii.*) A mature *F. albida* tree may produce 100 kg or more of nutritious pods every year.

- **Conserve fodder as hay or silage.** These are not widespread practices and are generally not recommended for smallholders. To make good silage, a watertight and airtight silo is required. Hay making relies on sub-drying, and if hay is made towards

the end of the wet season, its quality can be reduced by leaching of nutrients. Both practices demand labour when it is also needed for harvesting crops.

- **Use crop and industrial by-products.** Considerable quantities of cereal straw, husk, oil-seed residues, vegetable waste, and other crop residues from groundnuts, cowpeas, pigeon peas, soybeans, maize, rice, cotton, and sugarcane are available in many areas. Some residues are well-utilized, but a lot are wasted. Their feeding value needs to be appreciated with the development of practical methods of transport and feeding.

- **Use of supplements.** Where one specific nutrient is lacking, a supplement can have a dramatic effect on productivity. For instance urea, minerals and molasses give non-protein nitrogen, specific minerals and energy. Sesame and cotton seed cake are other sources of high quality protein and energy feed for livestock, particularly for pregnant and lactating animals.

- **Limit the numbers of animals.** For communal grazing areas, this depends on a good social structure in the community. Restrictions imposed by governments are rarely successful. Widespread veterinary treatment can aggravate the problem, but improved marketing offer opportunities to increase off take and should be encouraged.

HANDOUT 4: General Recommendations for Fodder Design and Management

How much land and forage do you need? The answer to this question depends on many factors, among which include:

- The type and numbers of animals targeted (species, age, sex, female vs. male, young vs. old, lactating vs. dry, etc.);
- The objective of production (dairy vs. meat, weight gain vs. maintenance, etc.);
- Climatic and environmental conditions;
- Farm type and size;
- Availability of existing forage resources in terms of quantity and quality at different seasons; and
- The type of feed supplement proposed, with estimates of its yield and quality.

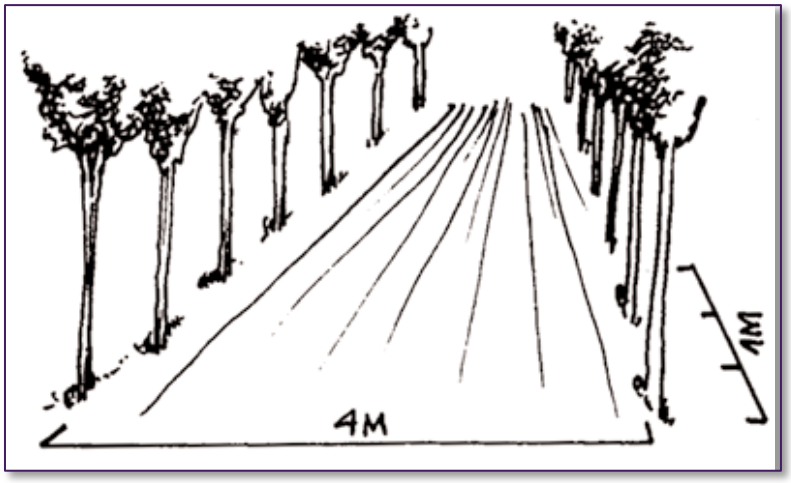
On a small piece of land measuring 10 m x 20 m, you may get enough fodder to feed five goats or sheep throughout the year. You can use *Gliricidia* as trees along with elephant or guinea grass. Try this system where rainfall is high; you will observe that grasses and trees grow rapidly. After establishment, do not cut the grasses for the first time before eight weeks and the trees before 12 months. Then you can cut the grasses once every four to six weeks and the trees once every two to three months, depending on the rainfall. Cut the tree branches at about 1 m from the ground and the grasses slightly lower at 75 cm.

Where on the farm can fodder plants be grown?

Living fodder fences: It greatly depends on the size of your land; fodder should not compete too much with your crops for valuable land. On small crop land, you can plant trees such as *Acacia albida* or *Gliricidia* to serve as living fences that separate your land from other land, and protect it from animals. Plant the fence from stem cuttings (*Gliricidia*) placed very close to each other (about 50 cm) to establish a living fence; space cutting farther if they will only be used as living fence posts. After six to eight months, start cutting the branches close to the ground, so that more branches can grow to form a strong fence. Keep cutting branches as the tree grows and feed the leaves to your animals.

Intercropping fodder trees: You can also plant fodder trees in the fields with your crops. This is called intercropping. Your crop will get more nitrogen from the tree leaves that fall and from the root of the trees, especially if you plant nitrogen-fixing trees.

You must make sure that the tree does not shade or cover your crop too much. Plant the trees 5, 7 or 10 meters apart to give you 60 to 80 plants per hectare, depending on how much land you have, and regularly cut down some branches and feed the fodder to your livestock. Another way is to plant the trees inside your crop land in rows and your crops such as maize, cassava, or cowpeas between the rows of trees. Space the holes in a row 1 meter apart and space the rows 4 meters apart.



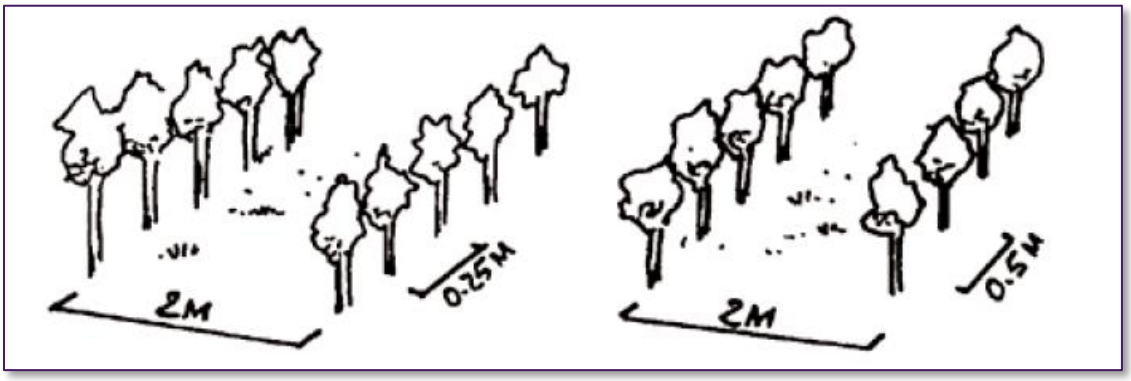
Spacing and arrangement recommended in Fodder Banks

Plant the seedlings at the beginning of the rains and take care of them as you normally take care of your crops; weed and fertilize them and protect them from animals. Let the trees grow for one year without cutting. At the beginning of the planting season of that second year, cut the trees very close to the ground (30–60 cm), and put the leaves in the space between the rows of trees, plowing them into the soil where you will plant your crops. These leaves will give nitrogen to your crops or will serve as mulch if left to cover the top of the soil.

- Your crops will grow, and the trees also will grow new branches which you will cut when they become too big to avoid shading your crops.

- Farmers have to decide when to cut the branches and this depends on the type of tree, the type of crop, the season, and whether the climate is wet or dry. A good guide is cut branches every six to eight weeks in humid areas and every ten to twelve weeks in drier areas.

As your crop matures, use more and more of the tree leaves to feed your animals, and use fewer leaves as mulch for your crop. During the dry season when you have no crops growing and your trees continue to grow, use all of the leaves to feed your animals. You can try other ways of establishing an alley cropped farm. Instead of establishing the trees first for a whole year, you can plant both trees and crops at the same time and take care of them together. You can try smaller row spaces, such as 2 m between rows, and 0.25 m between trees in a row, or 2 m between rows and 0.5 m between trees.



How much tree fodder can you feed to your livestock, and should you feed them green, fresh or dried?

- The easiest way to feed the fodder is to let your cattle, sheep, goats browse directly on trees in the range, in fallow land or in your backyard, if the trees are not too tall.
- If the trees are too tall, you may have to cut the branches and carry them to your animals to eat in the field, in your backyard, or in the stall.

In this way, your animals will eat fresh leaves and small stems. Goats will sometimes eat the bark of large stems and this is also good for them. If overgrazing is causing soil erosion where you live, you may choose to keep animals in stalls or fenced off fields and bring them fodder to eat. Another way is to feed dry forage. Cut it and dry it in the sun for a few days, then store it for feeding later on. It is in this dried form that you should feed the fodder to pigs and chickens. After sun-drying, crush or grind the leaves and small stems to make a leafmeal which you can feed directly or mix with other feeds.

How much tree fodder should be fed to livestock?

Many fodder trees such as *Gliricidia* and *Sesbania* contain very little or no toxic compounds. You can therefore feed a lot to ruminants, as much as they will eat, particularly during the dry season when there is no other green feed available. Other trees such as *Leucaena* contain toxic compounds that can harm your animals, including ruminants, pigs and chickens. You therefore need to mix them with other feeds to dilute the toxic compounds. If you already grow Leucaena, you will know that you it must be mixed with other fodder to avoid its toxic effect. For example, you can feed a mixture of *Leucaena* and *Gliricidia* to sheep and goats, making sure that *Leucaena* is not more than 30 to 40% of the mixture.

For non-ruminants such as pigs and chickens, dry and grind the fodder, and feed only between 5 to 15 percent of leaves and stems, and no more than 40 percent of pods and seeds in the diet. However, in any case, remember that the feeding behaviour of your animals fed fodder tree-based diets is a good indicator of what is to be done: If they aren't eating much, then you may need to reduce or to change the proportion of fodder from trees in their diets. Other parts of fodder trees that you can feed to livestock are the pods and seeds of trees. However, you should not feed such seeds raw or fresh; they should be dried, cracked or ground into flour before you feed them. If they are not cracked or ground before you feed them, the animal may not digest them well and the seeds will just pass out in the faeces with no real benefit to the animal.

Remember to be cautious; although you can even feed fodder from these trees and shrubs to *ruminants* as the only feed (100 %), it may be wise to mix at least two or more types of fodder. You can also mix one part (40 %) of the tree fodder with one and a half parts (60 %) of grasses, hay straw or crop residues (fresh, green or dried).

HANDOUT 5: Guide for Farmers and General Management of Fodder Banks

Trees and shrubs can supplement the quantity and quality of pastures for grazing livestock. They are an effective insurance against seasonal feed shortages or risk of drought. Fodder or browse production from trees and shrubs is one of the benefits of agroforestry. The first step in designing a fodder agroforestry system is to clearly determine your farming objectives. Figure 1 identifies various options for fodder agroforestry available to farmers. The following questions may help farmers to decide your fodder objectives:

- Do you have a fodder shortage at a particular time of year? How long does this period last? Is your fodder shortage due to the quantity of feed, or is quality?
- Is sufficient to just maintain your animals during the period of shortage, or are you expecting them grow or gain weight?
- Is your aim to save money through your fodder project?
- Are you expecting the fodder bank to increase the quantity of feed available to livestock?
- Are you expecting the fodder bank to increase the quality of feed available to livestock?

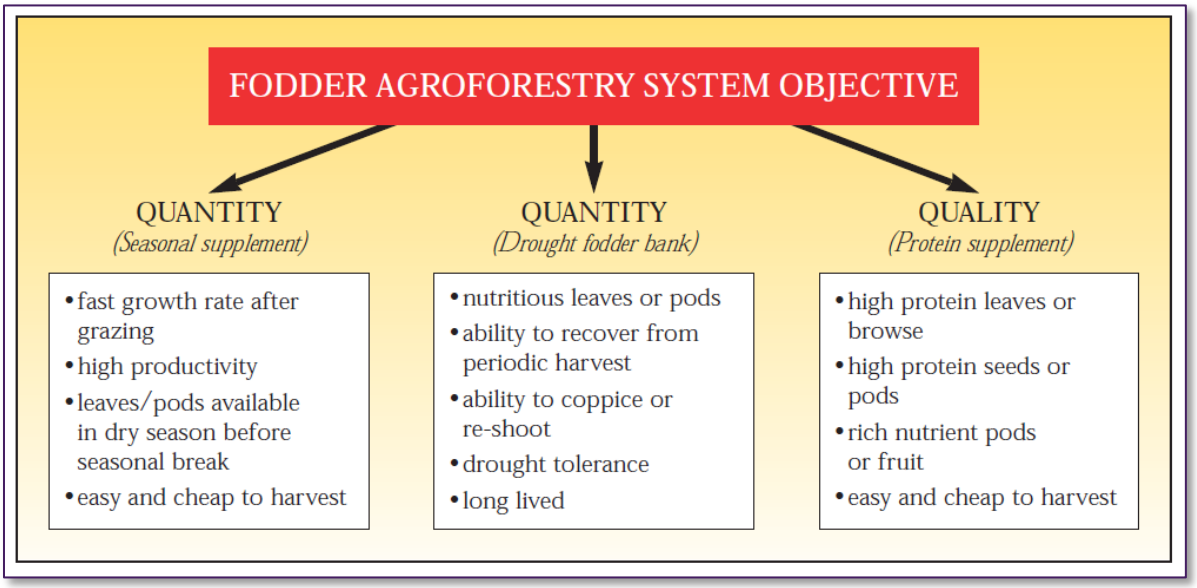


Figure #1: *Fodder banks options according to livestock needs and farmers objectives (Source World Agroforestry Center, 2012)*

Establishment and Management

Planting material. Direct seeding is normally recommended for fodder bank establishment. Seeds of many fodder bank species must be soaked in water or scarified to assure good germination. Sowing depth depends on seed and site characteristics. Most seeds should be sown at a depth equal to 1-2 times their width. In heavy soils, or when seed is small, sowing depth should be shallow. In arid and semi-arid environments sowing depth should be deep. For most seed types, successful sowing methods vary from place to place. Use those methods practiced locally for a similar type of seed.

Fodder bank establishment is also possible with seedlings or cuttings. However, because of the large number of plants needed this is often impractical. When seedlings or cuttings are used, tight plant spacing - 50 x 50 cm or 1 x 1 meter - is usually recommended. Species that can be established by cuttings include *Gliricidia sepium, Leucaena leucocephala, Cratylia argentea* and *Erythrina* spp.

Table: Adaptability to climate and soil conditions of the main species used in fodder banks.

Climate and soil conditions	Species			
	Leucaena leucocephala	***Cratylia argentea***	***Gliricidia sepium***	***Erythrina berteroana***
Relative fodder yield during dry season	High	Very high	High	Regular
Relative fodder yield in regions without dry season	Low	High	High	Very high
Adaptation to soils with drainage problems	Low	Low	Low	Regular
Adaptation to acid soils (ph ≤5.5	Low	Regular	Regular	Low
Adaptation to alkaline soils (ph ≥7.5	Good	Low	Good	Regular

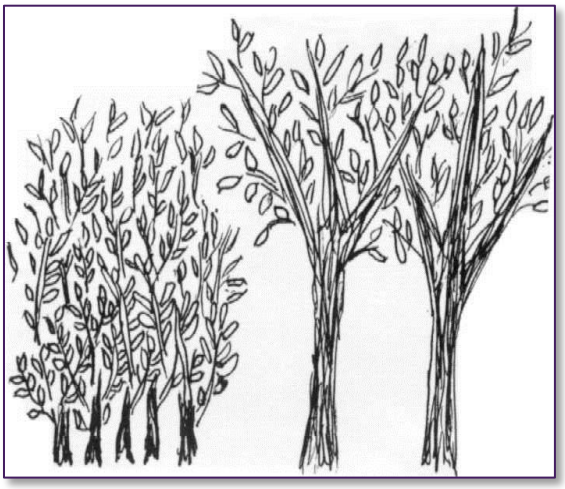
Source: CATIE (2008)

Post-establishment care: Although most fodder bank species are considered fast-growing, their initial growth is often slow. During this period seedlings are susceptible to weed competition for light, moisture and soil nutrients. Depending on weed growth, the fodder bank should be thoroughly weeded every 2-4 weeks. This level of weed, control should be maintained until the fodder bank species achieve a dominant canopy position and begin to suppress weed growth. This usually occurs six months after establishment. Also, because we are planting forage species, animals will eat the seedlings if given the opportunity.

HANDOUT 6: Silvicultural Management of Fodder Banks

Spacing and Design

To maximize dry season production, fodder banks should be dense, nearly pure stands. Recommended spacing varies from 50 x 50 cm to 1x1 m. Choice of spacing depends on management objectives. Total biomass yields per area increase at higher densities. Wider spacing is generally used when both fodder and small diameter wood for fuel or poles are desired. Closer spacing maximizes fodder production, but it may make access for harvest or grazing difficult. Spacing of 1x1 meter is common for many species.

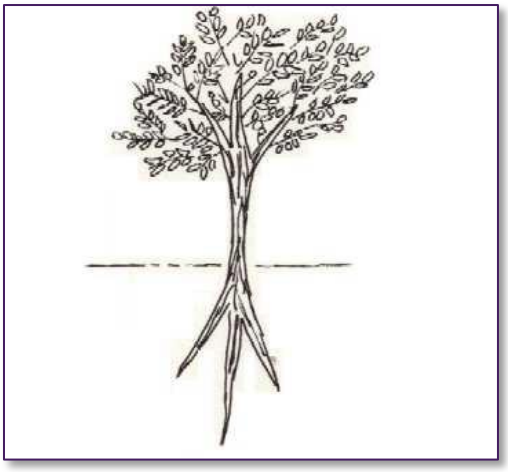


Closer spacing encourages maximum fodder production.
Wider spacing allows for better trunk and wood production.

Table: Technical design for fodder banks establishment in humid tropic (Source: CATIE, 2008).

Specie	Planting way	Row design	Distance between rows (m)	Distance between plants (m)	Number of plants for 1 ha
Fodder banks for Cut-and-carry					
Gliricidia and Leucaena	Horizontal	Single	1.5	0	3140
Gliricidia and leucaena	Vertical	Single	1.5	0.5	9410
Gliricidia and Leucaena	Vertical	Double	1.5	0.5 x 0.5	14110
Fodder banks for Grazing					
Erythrina spp	Horizontal	Single	2	0	2350
Erythrina spp	Horizontal	Double	2	0.5 x 0.5	3750
Erythrina spp	Vertical	Double	2	0.5 x 0.5	8064

Age at first harvest. In most circumstances the first harvest should be delayed until the bank is 9-21 months old. Actual age at first harvest depends on environmental conditions and bank growth. Under arid or poor soil conditions growth will be slow and the first harvest should be later. When growth is fast, the first harvest may be sooner. The goal is to allow fodder bank species to establish deep roots and thick trunk diameters. The resultant healthy plans have ample carbohydrate reserves and respond well to harvesting. Biomass production and the life duration of trees both increase when the first harvest is delayed. It is believed that the first harvest, whether from cutting or grazing, terminates the downward growth of taproots. This is an important consideration in arid and semi-arid environments.



To promote establishment of a healthy root-system, the first harvest should be delayed until trees are 9-21 months old.

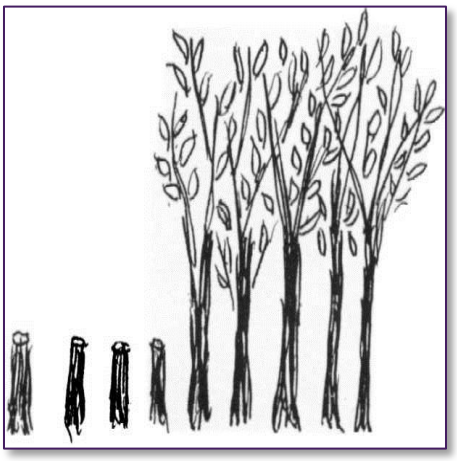
Grazing: Fodder banks can be directly grazed by livestock. This system saves labour and effort but can damage the plant. The key to direct grazing is to subdivide the fodder bank into paddocks. Livestock should be restricted to one paddock until the available fodder resource is fully utilized. Animals should then be moved to the next paddock. If environmental and plant growth conditions are favourable, fodder banks may be grazed year-round. Grazing periods are generally 1-2 weeks, followed by recuperation periods of 3-6 week (or three times the grazing period).

Cut-and-carry: Most fodder banks are managed through a cut-and-carry system in which the fodder is harvested and then 'carried' to the livestock. The animals may be a great distance from the fodder bank or just across a protective fence. Special harvesting equipment is available for fodder banks but all that is necessary is a sharp machete. A cut-and-carry system decreases fodder waste from animal damage and the necessity to monitor animals. However, labour inputs may be greater than with direct grazing systems.

Cutting height: To obtain maximum fodder production research studies have recommend a great variety of cutting heights. Review of these results suggests a standard cutting height of 50-200 cm. Besides fodder production, this height provides other advantages:

- Trees retain adequate foliage to ensure rapid regrowth and plant longevity; and
- Fodder is harvested with a minimum of bending or reaching.

After 2-3 years of production it is recommended to cut *Leucaena* back to 25 cm. This lower height removes much of the dead wood and rejuvenates foliage production. This may be true for other species also. However, regular cutting below 50 cm may cause increased mortality and decreased long-term productivity due to termite infestation and soil-borne diseases that can infect open cots in the tree close to the ground.



Cutting heights of 50-200 cm often maximize fodder production.

Cutting frequency: As with cutting height research studies have recommended a great variety of cutting frequencies. The most common cutting frequencies are 6-18 weeks. Generally, longer cutting frequencies, 12-18 weeks, generate more total biomass but increase the proportion of small wood production. Shorter cutting frequencies, 6-12 weeks, favour fodder yields and fodder quality. Younger foliage tends to have a higher nutritive value and palatability. However, repeated cutting after short frequencies decrease longevity. Standard cutting frequencies were developed for tropical conditions and tend to correlate with regrowth heights of 1-2.5 meters. Under arid, sub-humid or temperate conditions regrowth may take longer to reach this height, cutting frequencies may need to be extended.

Dry-season management: Dry-season fodder production is a main objective of fodder bank management. In areas with severe dry-seasons special management practices should be followed. Six to eight weeks before the beginning of the dry-season trees should be cut to the recommended height. The new foliage produced over the next few weeks will be retained well into the dry-season when it is most needed. Left uncut for 4-6 months, *Gliricidia sepium* will not retain its leaves into the dry-season. This may be true for other species as well. When the dry-season is very long or the area of fodder bank very large, the pre-dry-season harvest should occur in phases.

Fertilization: Fodder banks are long-term crops that must be properly maintained to continue high productivity. Even under direct grazing, fodder banks remove large amounts of soil nutrients from the site. These nutrients must be replenished by application of manures or other fertilizers. As previously mentioned, little is known of the nutrient requirements of most fodder bank species. However, as with most crops,

nitrogen, phosphorus and potassium are important nutrients. Application for these and other nutrients should be determined locally.

General Interactions in Fodder Banks

- Control of soil erosion improves with closer spacing in rows. Once the fodder bank is well established, grass should be allowed to grow in the area between double rows.

- Competition between fodder bank trees and grasses will not be as severe as during the establishment period. Tree roots will feed from deep in the soil; grass feed from near the surface.

- Their difference in height will also decrease competition for sunlight. This two-tiered system produces more fodder per area than either plant type alone. The grass grown in the inter-row area should be an excellent fodder species.

- Competition between trees and grass should be monitored constantly so that fodder bank productivity does not decrease. The natural establishment of poor quality fodder grasses should be closely controlled.

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Module 10: Shade Management in Cocoa & Coffee Farms

Objectives

- To introduce farmers to a tool for the objective analysis and improvement of the shade canopies of cocoa and coffee farms that:

  ✓ Introduces the concepts for shade design and management; and
  ✓ Describes a protocol to diagnose the current conditions of shade canopies.

- To allow farmers to learn how to design and to choose the most promising agroforestry interventions in shade canopies according to the farm families' objectives and resources.

Supplies

- Forms for botanical inventory (Handout 1)
- Steps & the Guide for diagnosing the shade canopy (Handouts 2 & 3)
- Pencil and notebook
- Flip charts and markers

Preparation

- Before this meeting, work with the farmers to select a farm with cocoa and/or coffee farm where the session can held.

- Review the guide and steps for carrying out the shade canopy diagnosis.

Venue

Farm with cocoa and/or coffee shaded plantation.

Total Time

1 day (4-5 hours)

Activities

1. Start the session by facilitating a discussion with the farm family to determine their objectives and vision for the cocoa or coffee plantation.

NOTE

The vertical and horizontal distribution of the canopy cover and its botanical composition affect the quantity and quality of shade. The key questions to be answered is how much shade should there be in any given plantation? The method for diagnosing the canopy has five steps.

1. Define what you want to get from the plantation.
2. Evaluate the site where cocoa or coffee is planted
3. Evaluate the self-shading and phenology of the cocoa or coffee
4. Evaluate the canopy and the shade trees
5. List the plant species and their shading characteristics.

2. Use the diagnosis methodology to define the strategy needed to achieve the farm family's objectives. Ask the groups to do the diagnosis using the five steps below:

Step 1: ***Define what the farm family want to get from the cocoa plantation:*** Ask the farm family to say what the family wishes to get from the farm and how much are they willing to invest in managing it. For example, a family might say "we want to give priority to cocoa cultivation and we are going to renew some trees with new grafts to double productions. Another family could say, "we want to produce cocoa, plantain and timber in the same plot, that the reason why we combine cocoa with valuables trees.

Step 2: ***Evaluate shade using the seven site characteristics that affect shade on the cocoa farm below:***

- **Wind:** If there are strong winds, it is necessary to plant windbreaks to protect the cocoa. The windbreaks are planted in rows and perpendicular to the direction the wind comes from. These barriers provide the cocoa with lateral shade.

- **Clouds:** If there is much cloudiness during the year, fewer trees are needed in the shade canopy.

- **Soil fertility:** If a cocoa plant receives a lot of light, it is going to need a lot of water and nutrients. If the soil is not fertile or is not fertilized, more shade is needed.

- **Availability of water:** In humid zones or with irrigation, the plants in the shade canopy do not affect the cocoa negatively. In areas that have six or more continuous dry months, it is not a good idea to plant cocoa, unless irrigation is available. The plants in the shade canopy use part of the water in the soil and can dry it out and negatively affect the growth and production of the cocoa.

- **Slope of the land:** If the cocoa farm is planted on a hillside or sloping land, it many receive sun light only at certain hours of the day depending on the degree of the slope, latitude and orientation.

- **Tall plants on the boundaries of cocoa farms:** Trees and other tall plants on the boundaries of the cocoa farm block the sun and cast

lateral shade for several hours each day depending on the height of the boundary plants and their orientation with respect to the sun's movement.

- **The movement of the sun:** The movement of the shadows over ground depends on the movement of the sun across the sky, which varies according to the time of the year and where on the planet the cocoa farm is located.

Step 3: ***Evaluate the self-shading and phenology[3] of the cocoa:*** conduct a walk-through of the farm and identify the shading interactions taking place as well as phenlogical conditions. Negative and positive interactions should be highlighted.

NOTE

The shade that a cocoa plant casts over itself is called self-shading. The shade that neighbouring cocoa trees cast onto each other is also self-shading. Self-shading depends on the age and size of the cocoa plant. Later, as the cocoa plants grow and the crown develops the leaves they begin to cover and shade the leaves below and increase self-shading. This means that more shade from the canopy is needed for young cocoa than for adult cocoa. So it is recommended that farmers plant bananas, plantains, cassava and other fast growing species to compensate for little self-shading by the young cocoa.

In addition to the age-dependent changes in self-shading that occur as cocoa plants grow older and bigger, light requirements of the cocoa tree vary according to its annual cycle (leaf flushing; flowering, fruit development and filling; fruit maturation; radial growth of stem, branches and roots; quiescent phase). Light is needed at flowering and pod filling. For optimal cocoa performance, shade must be adjusted to the phenological rhythms of the cocoa plant by timely pruning or pollarding of the shade trees.

Step 4: ***Evaluate the canopy and the shade trees:*** Ask the AFFS groups to conduct a farm walkthrough to determine whether the shade is distributed evenly on all of the plot or whether there are areas with a lot of shade and holes without shade or with too little shade. Negative and positive interactions should be highlighted.

NOTE

If there is a hole in the shade canopy, we close it by planting a tree or choosing from among the ones that grow there naturally. The ideal is for shade to be evenly distributed throughout the farm, with all cocoa plants having the same shade conditions to grow and produce. On the other hand, If we find patches with a lot of shade, we thin or prune some trees to open the canopy and let more light get to the cocoa. Patches with a lot of shade produce too much humidity, which favours diseases that are very harmful to the cocoa, such as black pod.

Step 5: ***List the plant species and describe seven characteristics of each one:*** Use the template in Handout 1 to list the plant species that we have in the canopy and describe the following seven characteristics of each one:

a. Name of the plant;

[3] The scientific study of periodic biological phenomena, such as flowering, breeding, and migration, in relation to climatic conditions.

b. Goods and services it provides;
c. Height of the trunk, that is, the distance from the ground to where the crown begins;
d. Height of the crown;
e. Width of the crown;
f. Whether the crown is sparse or dense; and
g. Months of the year when the crown has no leaves.

NOTE

These characteristics affect shade on the cocoa plot in many ways. For example, if we use trees with wide crowns, we can only plant a few trees on each hectare of cocoa. Farmers know that tall tree crowns provide sparse shade and low tree crowns provide heavy shade. The shade cast from a tall tree crown moves more quickly over the ground than the shade from a low tree. Also it is possible to take advantage of this. Tall trees may have heavy crowns and yet do not cast a lot of shade onto the cocoa. On the other hand, short trees should have sparse crowns, to avoid over shading the cocoa. Otherwise, if the crown is very dense, only plant few trees per hectare of this species and prune them regularly to let the light reach the cocoa.

3. After completing the five steps above, have the AFFS groups record the data on flip charts. It will be also useful to have a sketch of the plantation reflecting where more or less shade and places without it are.

4. With all the information visible (flip charts in walls or on the floor), the facilitator leads a brainstorming exercise regarding the current interactions in the different places of the plantation, highlighting the positive and negative interactions.

5. Using the finding of the brainstorming session and taking into account the farm family's objectives for the plantation, the group determines what shade conditions would be the best for the plantation and propose interventions needed to improve the shade canopy.

6. The group should discuss all the suggestions with the farm family members and use this information to make a final evaluation of the capacity of the family to implement them.

Daily Summary and Observation Analysis

Reconvene the farmers in a circle at the end of the session. Facilitate the daily summary by asking questions such as:

- What did you learn today?
- What was easy about today's activities?
- What was difficult in today's activities?
- What observations do you have?
- What are the advantages of working together?
- What costs are involved and how can we decrease costs?

REFERENCE FOR DISCUSSION

- It is necessary to take into account the objectives of the family to ensure that the agroforestry innovations will be adopted.
- A well-done diagnostic is the basis for identifying the most promising agroforestry interventions in the shade canopy.
- The comprehension of the interactions and how to manage them is a key factor for the success of the agroforestry interventions.
- Families must be realistic about what they can do and with what available resources to accomplish the plan to improve the shade canopy to obtain the goods and services desired.

Handouts

Facilitator's Resource

Handout 1: Form - List the Plant Species and Their Shading Characteristics
Handout 2: Detailed Explanation of the Steps for the Diagnostic of Shade Canopies
Handout 3: Guide for Diagnosing the Shade Canopy of a Cocoa & Coffee Farms
Handout 4: Managing Interactions
Handout 5: Silviculture

HANDOUT: Facilitator's Resource

Cocoa and coffee are commonly cultivated by smallholders in association with trees that benefit the cocoa plant (through climate amelioration, soil protection and maintenance of fertility); provide products for home and farm use or for sale (timber, fruits, firewood, medicine, fibre or construction materials, honey, resins, etc.); and provide services to the household (cultural and aesthetic) and to society (soil, water and biodiversity conservation and carbon sequestration for mitigation of climate change). Diversified cocoa/coffee cultivation makes farm income larger and less variable and the business more resilient to perturbations such as falling cocoa prices or climate change.

In most cases, the botanical composition of the cocoa/coffee shade canopy is sub-optimal for satisfying the needs of the smallholder farmer. Shade levels are often inadequate for the growth and yield of the cocoa/coffee trees, and canopy cover is unevenly distributed over the plot. Most cocoa/coffee shade canopies have low species richness and simple vertical and horizontal structure to facilitate crop management. Poor agronomic practices such as pruning and thinning of shade trees (especially of timber trees) are the norm, resulting in suboptimal yields of both cocoa and companion trees. In this manual we propose a simple protocol to help agronomists and farmers analyze and improve their shade canopies.

Key Definitions

A cocoa farm, also called cocoa plot, is a piece of land where cocoa is grown with or without other trees, palms, bananas and other species of plants. When cocoa is grown in conjunction with trees and other tall plants that provide shade, all these trees and plants together are called the shade canopy of the cocoa farm or simply, ***the canopy***.

Goods or **products** are things that the cocoa farm provides that we can touch with our hands. Some products and services get from the cocoa farm are: Lumber to build houses, boats and furniture; firewood, palm leaves and stalks for roofs, floors and walls of the house; fruits for the family to eat, sell and feed to domestic and wild animals; industrial products such as palm oil, rubber coconut and medicinal plants.

Services are things that benefit the farm, the environment and people but we cannot touch. For example the reduction of soil erosion, the improvement of soil fertility, and reduction of greenhouse gases from the atmosphere by carbon sequestration in tree trunks.

Self-shading refers to how the upper leaves in branches in the crown of a cocoa tree cast shade on lower leaves. Furthermore, neighbouring cocoa trees cast shade on each other. The shade cast by upper leaves and branches plus the shade cast by neighbouring trees is called 'self-shading'. Self-shading is determined by a combination of factors related to the form and size of the cocoa tree, and planting configurations and spacing – alone and in combinations. Triangular planting arrangements can 'pack' cocoa trees more densely in the plot than square or rectangular configurations. Self-shading is higher in more 'packed' planting configurations.

Interactions refer to the influence of one component of the system over the performance of other components of the system. Examples of interactions are the influence of shade on cacao or coffee plants from surrounding and competition between plants and trees for water and nutrients.

HANDOUT 1: Form - List the Plant Species and their Shading Characteristics

Name of the plant	Goods and Services it Provides	Height of the trunk	Height of the crown	Width of the crown	Crown sparse or dense?	Months of the year when the crown has no leaves

HANDOUT 2: Detailed Explanation of the Steps for the Diagnostic of Shade Canopies

Diagnostic of the Shade Canopy

The vertical and horizontal distribution of the canopy cover and its botanical composition affect the quantity and quality of shade. **The key questions is** h*ow much shade should there be in any given cocoa plantation?* The method for diagnosing the canopy has five steps.

1. Define what you want to get from the plantation.
2. Evaluate the site where cocoa or coffee is planted.
3. Evaluate the self-shading and phenology of the cocoa or coffee.
4. Evaluate the canopy and the shade trees.
5. List the plan*t species and their shading characteristics.*

FIRST STEP: ***Define what you want to get from the cocoa plantations:*** Describe what your family wishes to get from the cocoa farm and how much are you willing to invest in managing it. For example, a family might say "we want to give priority to cocoa cultivation and we are going to renew some trees with new grafts to double productions. Another family could say, "we want to produce cocoa, plantain and timber in the same plot, that the reason why we combine cocoa with valuables trees.

SECOND STEP: ***Evaluate the site where the cocoa is planted:*** Evaluate seven site characteristics that affect shade on the cocoa farm:

- **Wind:** If there are strong winds, it is necessary to plant windbreaks to protect the cocoa. The windbreaks are planted in rows and perpendicular to the direction the wind comes from. These barriers provide the cocoa with lateral shade.

- **Clouds:** If there is much cloudiness during the year, fewer trees are needed in the shade canopy.

- **Soil fertility:** If a cocoa plant receives a lot of light, it is going to need a lot of water and nutrients. If the soil is not fertile or is not fertilized, more shade is needed.

- **Availability of water:** In humid zones or with irrigation, the plants in the shade canopy do not affect the cocoa negatively. In areas that have six or more continuous dry months, it is not a good idea to plant cocoa, unless irrigation is available. The plants in the shade canopy use part of the water in the soil and can dry it out and negatively affect the growth and production of the cocoa.

- **Slope of the land:** If the cocoa farm is planted on a hillside or sloping land, it many receive sun light only at certain hours of the day depending on the degree of the slope, latitude and orientation.

- **Tall plants on the boundaries of cocoa farms:** Trees and other tall plants on the boundaries of the cocoa farm block the sun and cast lateral shade for several hours each day depending on the height of the boundary plants and their orientation with respect to the sun's movement.

- **The movement of the sun:** The movement of the shadows over ground depends on the movement of the sun across the sky, which varies according to the time of the year and where on the planet the cocoa farm is located.

THIRD STEP: ***Evaluate the self-shading and phenology of the cocoa:*** The shade that a cocoa plant casts over itself is called self-shading. The shade that neighbouring cocoa trees cast onto each other is also self-shading. Self-shading depends on the age and size of the cocoa plant. Later, as the cocoa plants grow and the crown develops the leaves they begin to cover and shade the leaves below and increase self-shading. This means that more shade from the canopy is needed for young cocoa than for adult cocoa. So it is recommended that farmers plant bananas, plantains, cassava and other fast growing species to compensate for little self-shading by the young cocoa.

In addition to the age-dependent changes in self-shading that occur as cocoa plants grow older and bigger, light requirements of the cocoa tree vary according to its annual cycle (leaf flushing; flowering, fruit development and filling; fruit maturation; radial growth of stem, branches and roots; quiescent phase). Light is needed at flowering and pod filling. For optimal cocoa performance, shade must be adjusted to the phenological rhythms of the cocoa plant by timely pruning or pollarding of the shade trees.

FOURTH STEP: *Evaluate the canopy and the shade trees:* the first thing we must do is go through the cocoa farm to see whether the shade is distributed evenly on all of the plot or whether there are parches with a lot of shade and holes without shade or with too little shade. If there is a hole in the shade canopy, we close it by planting a tree or choosing from among the ones that grow there naturally. The ideal is for shade to be evenly distributed throughout the farm, with all cocoa plants having the same shade conditions to grow and produce. On the other hand, If we find patches with a lot of shade, we thin or prune some trees to open the canopy and let more light get to the cocoa. Patches with a lot of shade produce too much humidity, which favors diseases that are very harmful to the cocoa, such as monilia, witches' broom and black pod.

During the third and fourth steps positive and negative interactions must be highlighted.

FIFTH STEP: *List the plant species and describe seven characteristics of each one.*

Use the template in Handout 1 to list the plant species that we have in the canopy and describe the following seven characteristics of each one:

1. Name of the plant;
2. Goods and services it provides;
3. Height of the trunk, that is, the distance from the ground to where the crown begins;
4. Height of the crown;
5. Width of the crown;
6. Whether the crown is sparse or dense; and

7. Months of the year when the crown has no leaves.

These characteristics affect shade on the cocoa plot in many ways. For example, if we use trees with wide crowns, we can only plant a few trees on each hectare of cocoa. Farmers know that tall tree crowns provide sparse shade and low tree crowns provide heavy shade. The shade cast from a tall tree crown moves more quickly over the ground than the shade from a low tree. Also it is possible to take advantage of this. Tall trees may have heavy crowns and yet do not cast a lot of shade onto the cocoa. On the other hand, short trees should have sparse crowns, to avoid over shading the cocoa. Otherwise, if the crown is very dense, only plant few trees per hectare of this species and prune them regularly to let the light reach the cocoa.

HANDOUT 3: Guide for Diagnosing the Shade Canopy of a Cocoa & Coffee Farms

The Family

- What do you want from the cocoa farm? What goods and services do you want from the shade canopy? How much are you willing to invest to improve the farm?
- Which of the six type of cocoa farms does your farm most resemble?
  - ✓ Cocoa without shade;
  - ✓ Cocoa farm with one species that only serves for shade;
  - ✓ Cocoa farm associated with other perennial crops;
  - ✓ Cocoa with mixed shade;
  - ✓ Cocoa farm under natural thinned forest or rustic cocoa; and
  - ✓ Cocoa agroforest.

The Site

- Make a hand drawn map of the cocoa farm.
- Is the cocoa planted on flat land or land with a steep, medium or slight slope?
- Which directions does the slope face? (North, south, east, west, northwest, etc.)
- How many months of the year do strong winds blow? From which direction do they blow? What species are used in this area for windbreaks?
- In which month of the year is it quite cloudy?
- Is the soil fertility high or low?
- Do you apply fertilizers to the cocoa? Indicate which ones and how much per year (kg, pounds, quintals or tons) per unit of area (acre, hectare or other unit of measurement).
- In which months of the year is the soil on the cocoa farm dry because of lack of rain? Is irrigation available?
- Are there hills or tall vegetation at the edge of the cocoa farm that produces lateral shade on the cocoa plot? How many hours per day does the cocoa plot receive lateral shade?

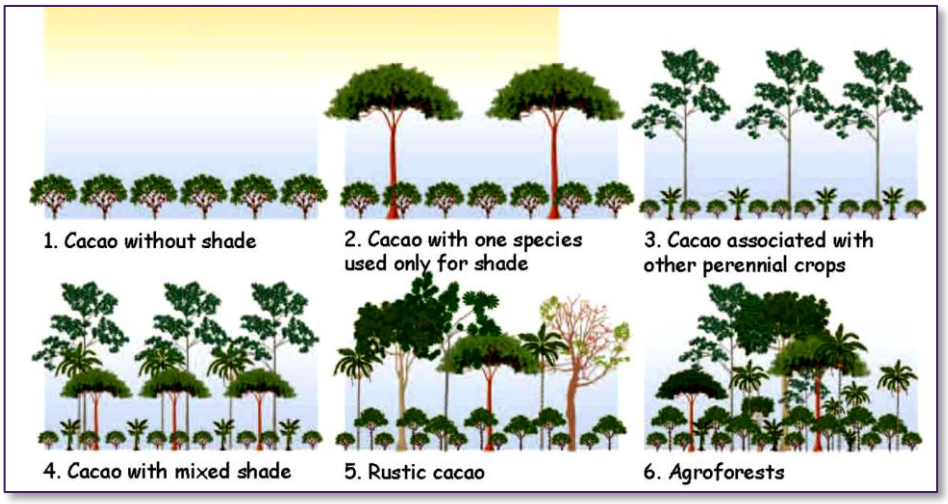
The Cocoa

- Is there little, adequate or too much self-shading in the cocoa farm?
- Is the cocoa young, mature or old?
- Is the cocoa from seed, grafts or mixed? If is mixed, what is the percentage of grafted plants?
- At what distances and arrangements in the cocoa planted? What is the number of plant per hectare?
- In what phenology status (flushing of leaves, flowering, fruit enlargement, ripening fruit, resting phase) is the cocoa at the time of the inspection?
- How often are the cocoa trees pruned? Once a year, every two years, infrequently?

The Shade Canopy

- Indicate on the sketch of your cocoa farm the areas where there are holes without shade or with little shade and patches with a lot of shade. Estimate how many trees would have to be thinned or pruned to open up the patch. Estimate how many trees would need to be planted or selected from natural regeneration to fill the holes.
- Inventory the species un the shade canopy. Note how many individuals there are of each species
- Determine whether these species or the number of plans per species is in line with what we expect from the cocoa farm.

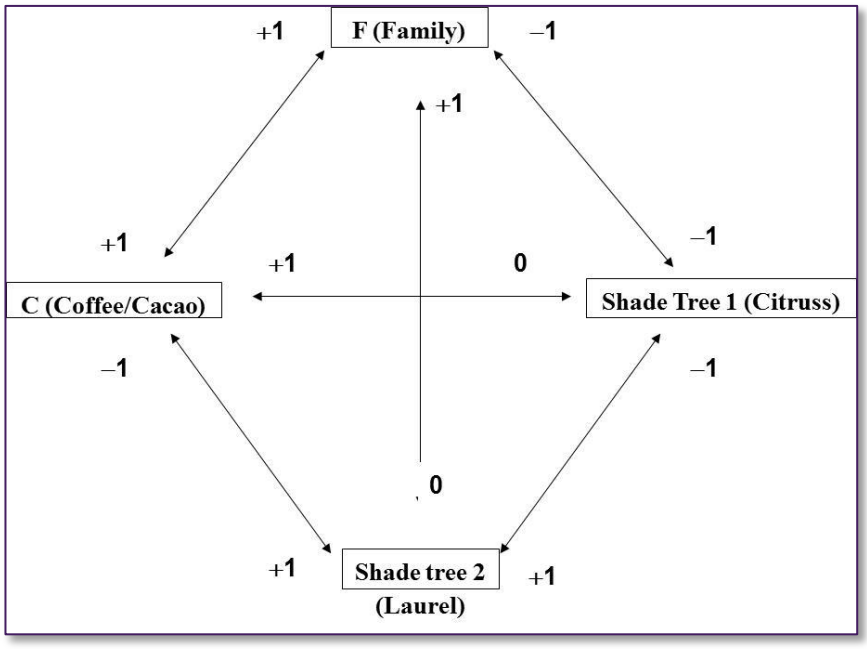
The six most-common types of cocoa farms in the world. This picture could be useful to help people to think about what kind of shade canopy they want



HANDOUT 4: Managing Interactions

Cocoa and coffee are cultivated with companion trees that produce positive and negative interactions. The main interactions that farmers need to handle are:

- Shade cover and pattern in cocoa and coffee plantation that will be reduce the main crop yield. It is possible to reduce this effect managing tree density and arrangement of the shade canopy.
- Excessive shade will be beneficial for pest and diseases to spread. It is possible to manage this condition by thinning shade trees and pruning plants.
- Shade trees could be a habitat for pests. It is possible handle this by selecting the right shade tree and managing the shade levels for cocoa and coffee during the year.
- Shade trees help maintain soil organic matter, reduce evaporation from soil, and retain soil productivity.
- Cocoa cultivation offers the unique opportunity to combine economically viable production with the conservation of soil, water and biodiversity and the provision of other environmental services to society.

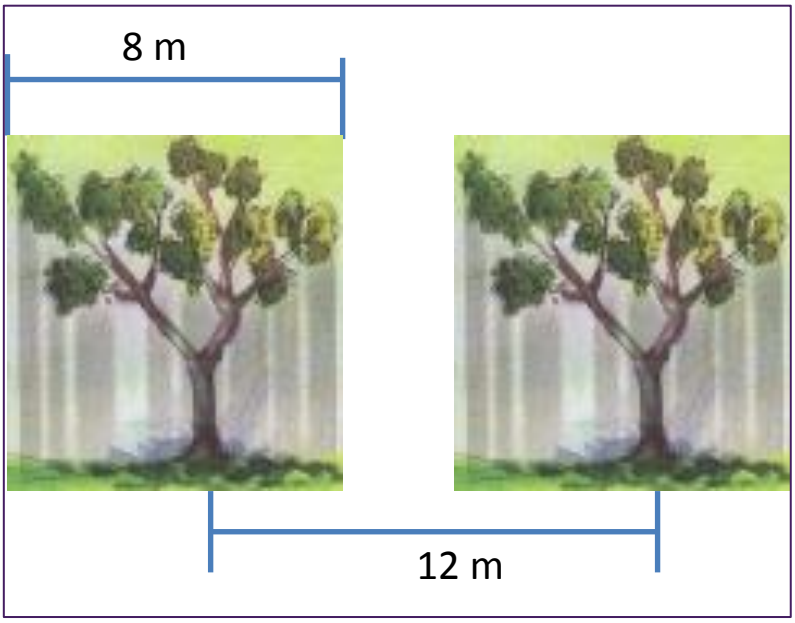


Basic model for positive/negative interactions between cocoa/coffee and shade canopy.

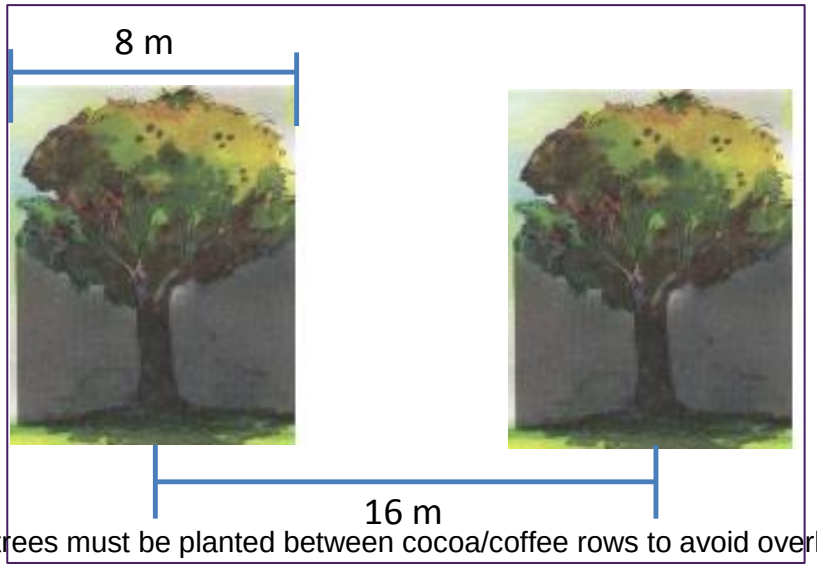
HANDOUT 5: Silviculture

- There are three basics rules to plant and manage timber or shade trees in a coffee/cocoa plantation:

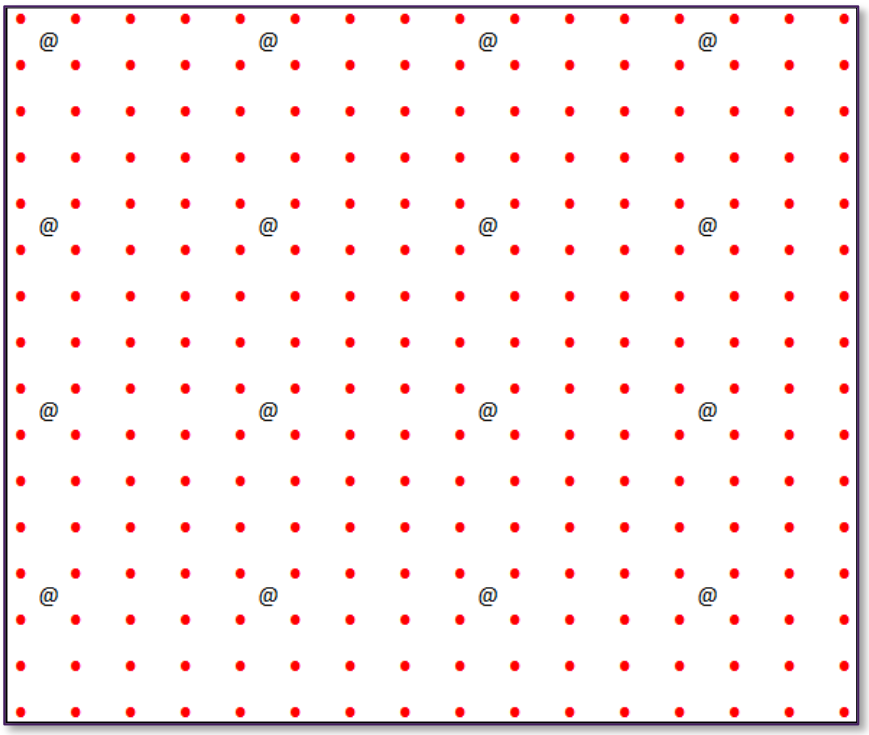
  ✓ Distance between shade trees must be at least 1.5 times the width of the crown size of a mature tree if the crown is lightly or moderately dense.



  ✓ Distance between shade trees must be at least 2 times the width of the crown size of a mature tree if the crown is highly dense.

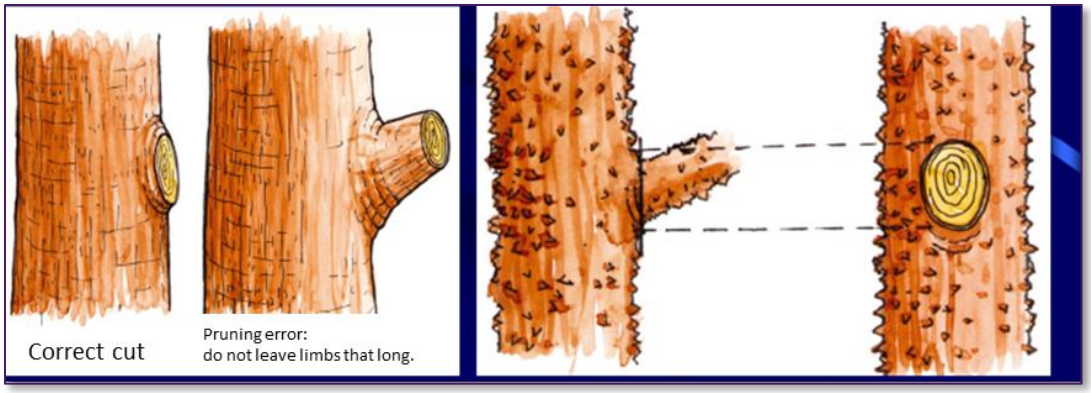


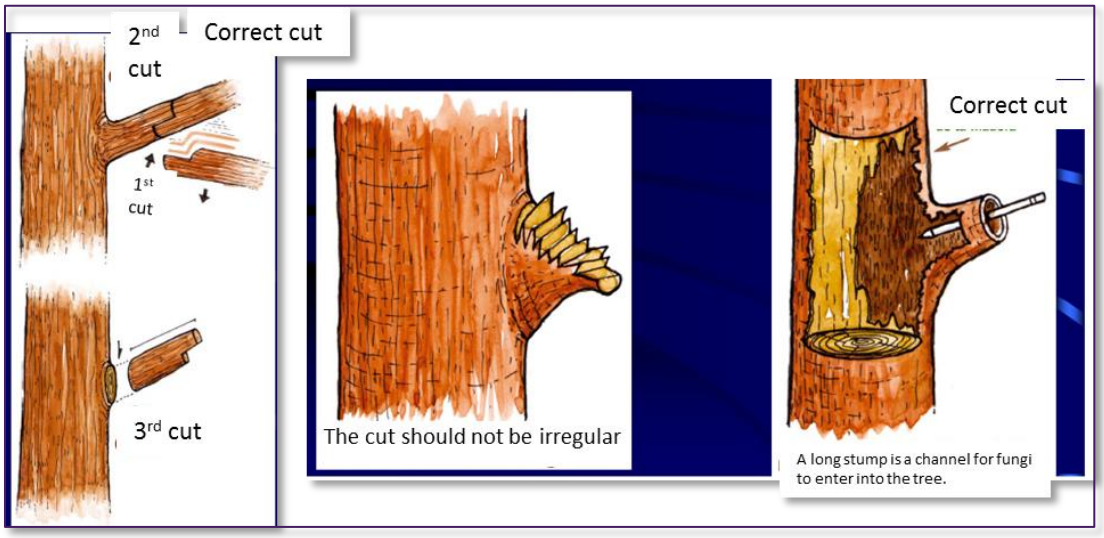
  ✓ Shade trees must be planted between cocoa/coffee rows to avoid overlap.



Points = cocoa trees (e.g. 4x4m); @ = shade trees (e.g. 16x16)

- Shade trees can be established either by planting seedlings or by selectively assisting volunteer seedlings that sprout in the field.
- Deciduous trees should be cut when they have lost foliage and the cup is lighter.
- Any timber tree should be pruned during its life to improve the growth, the form of the trunk (timber) and to avoid excessive shade over cocoa/coffee trees.
- When pruning, it is important to cut the branches as close to the trunk to encourage a quick healing and avoid letting internal tissues begin to root. When the branches are large and coarse the cut must be in several steps. See the following pictures





- Before cutting a large tree, the crown must be pruned to reduce weight and size of the tree. This will considerably reduce the damage on cocoa/coffee plants.
- The timber should be cut before the heavy pruning of cocoa, so as to facilitate the "repair" of damaged plants.
- Damage to the cocoa plantations may be reduced if the people doing the pruning or felling are trained in directional felling.
- On sloping ground, the trees should turn upward slope so that they fall with less force on cocoa.
- The harvest of timber should be prioritized during periods of low prices and/or low cocoa/coffee production.

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Module 11: Planting & Protecting Seedlings

Objectives

1. To properly describe the steps of outplanting potted forestry and fruit tree seedlings.
2. To know the differences between planting and care for forestry seedlings vs. fruit trees.
3. To practice transporting and planting seedlings.
4. To practice making cuvettes, firebreaks and other protective measures.

Supplies

- Hoes or shovels for digging;
- Knives or razor blades for slicing plastic seedling pots;
- Watering cans;
- Wheelbarrows or other appropriate methods for transporting seedlings; and
- Any recommended inputs for holes (examples: compost or pesticides).

Preparation

Site preparation includes delineating the site, clearing the ground, marking the space for each tree, digging the holes, and amending the soil. If applicable, water should be available for irrigation. Protection should be in place.

Time

3 hours

ACTIVITIES

Activity 1: Practice Planting Forestry and Fruit Trees

Organize a tree planting day with the farmers. It should be conducted at the demplot or one of the farmer's fields.

- How do we know that the soil is ready for planting?
- What happens if you place the tree roots into dry ground?
- What type of preparation should we do to the holes once they are dug?

- When should we dig the holes?
- How big should the hole be for a forestry seedling?
- How big should the hole be for a small fruit tree seedling?
- How big should the hole be for a large fruit tree seedling?
- When digging the hole, why should we separate the top dirt from dirt lower in the hole?
- How do you know if the seedling is planted at the right level?
- What happens if your hole is too deep?
- What happens if your hole is too shallow?
- What should we do if the bottom of the hole is hard and compacted?
- When are the best times to plant? Why?
- What are the steps in planting a standard small seedling?

Activity 2: Protection

Instruct the farmers to use whatever materials they have collected to put in protective measures.

- Why should we rake the weeds away from seedlings?
- How can we protect seedlings from fires?
- What can we use to protect the seedlings?
- How will we make sure that oats do not eat them?
- Should we protect all the new trees with a fence or should we protect individual plants?
- Do we have thorny branches available to use?

Activity 3: Moon Mounds

Instruct the farmers to work in small groups and practice forming mounds of dirt in crescent moon shapes around seedlings that would benefit from added water catchment. Also have the farmers practice making concentric circles of mounds around a larger fruit trees on the property to assist with compost and irrigation.

- How can we channel water to a seedling?

- How can we keep water away from the trunks of large fruit trees?
- What happens if water pools next to the trunks of trees?

Daily Summary and Observation Analysis

Reconvene the farmers in a circle at the end of the session. Facilitate the daily summary by asking questions such as:

- What did you think about the work today?
- What was easy about today's activities?
- What was difficult in today's activities?
- What observations do you have?
- What are the advantages of working together?
- What costs are involved and how can we decrease them?

Handouts

Handout 1: Planting Tips
Handout 2: Protecting Saplings

HANDOUT 1: Planting Tips

DEFINITIONS

Transplanting – transferring a seedling from one place (where it germinates) to another place (usually in the nursery)

Outplanting – finally planting the seedling in the ground

Planting Site Considerations

The planting site should be completely ready well before the first rains are due, because the trees must be transplanted as soon as sufficient rain has fallen to moisten the top 20 cm of soil. Owing to the fact that the rains come to the various regions of Jamaica at different times, we generally refer to November as the peak planting time and April being a second option. The tree roots cannot be placed into dry ground if they are to survive.

Site preparation includes delineating the site, clearing the ground, marking the space for each tree, digging the holes, and amending the soil. If applicable, water should be available for irrigation. It will not be necessary to irrigate seedlings, but providing water when they are first planted helps the roots adjust.

Hole Preparation

In areas with less than 1,200 m annual precipitation, holes should not be dug before they are to be used. The purpose of pre-digging holes is to save time once the rains have begun, and to allow rain to fall directly into the hole, thus supplying extra moisture. But in dry areas, rain often is driven by wind and drops hit the sides of holes only, plus extreme heat makes the interior of the hole very hot and dry.

Hole size varies according to geographic region and according to the type of tree. The size of the hole for citrus and mangos is 80cm x 80cm x 80cm and for small fruit trees is 50cm x 50cm x 50cm. (For fruit trees do not pre-dig the holes.)

The general size of the hole for all forestry trees tends to vary between 20 and 60 cm. Places with more rain require a smaller hole. Places with bad soil and less rain where saplings have more difficulty to grow should have larger holes prepared. This size should hold either open-rooted or potted seedlings easily.

When digging the soil is placed in two equal piles, one on each side of the hole. The first 20cm or so is topsoil, and the second 20cm is the subsoil. A shovel-full of compost or manure is mixed with the topsoil and filled in first. Next, the subsoil is added and packed around the seedling.

The holes should be deeper than the height of the polypot. You want to dig deeper than the depth of the roots so as to loosen up the soil where roots will penetrate. When

planting the actual seedling, be sure to line up the root collar with the top level of the ground.

Planting Techniques

Transporting plants in plastic pots is relatively easy for the plants, but is more difficult in other ways (heavy). The best time to outplant is in the early morning or late evening. The process can be executed in five easy steps:

1. Cut the bag 1 cm at the bottom.

2. Slit the bag up the side.

3. Position the bag a little above the lip of the hole.

4. Tap down the soil to prevent air pockets.

5. Generously water the trees.

6. Roots should be clipped and some leaves can be removed to prevent transpiration. Be sure to leave the terminal bud intact.

Mounds

Mounds of dirt or compost are used to either trap water near small seedlings or to keep water from pooling next to the trunk of larger trees. The reason to keep water from pooling next to the trunk is to minimize the chance of fungal infections.

Irrigation

Watering: Watering of seedlings after they have been planted is rare. Usually farmers try to give the seedlings water immediately upon outplanting.

HANDOUT 2: Protecting Saplings

Seedlings can be protected through a variety of methods. Fencing is often used to protect large planting areas. Protection and guards for individual trees are also common, particularly for higher value fruit trees, hardwoods and ornamentals.

Weed and Fire Management

Each planting site should have a weeding strategy. Weeds compete for moisture and nutrients and crowd out a young seedling. Though weeds can serve as camouflage for seedlings during the dry season, they can also aid in the spread of brush fires that can destroy entire fields very quickly. Raking weeds away from newly planted seedlings, or preparing the area around a hole where a seedling will be planted are ways to manage weeds. Some farmers will argue that having weeds helps disguise the seedlings from grazing animals. Again, each farmer should come up with his or her own weed management strategy.

We recommend eliminating the strongest weeds around each of the seedlings, leaving some brush cover for protection from animals, and we recommend creating a firebreak around every planting site. One way to make a firebreak is by clearing 4 meters of land using rakes, then leaving a space of 12 meters, and then clearing another band 4 meters wide. The 12 meter band of grass in between the two other cleared areas is then control-burned, ultimately leaving a 20 meter wide firebreak.

Protection with Local Materials

The most crucial step is to help seedlings survive their first dry season. By the end of the second rainy season, trees are usually tall and strong enough that animals can only cause minimal damage.

- There are numerous low cost barriers and deterrents to use. The most important thing is to use local materials creatively. Some farmers use old straw mats, bricks, and even old tires to protect seedlings.

- For new fruit tree plantations, individual trees, which are often spaced 6-12 meters apart, can be covered with rice sacks, onion sacks, or any other similar bag that allows for some sun and air circulation. These plastic mesh sacks can be purchased at most local stores or markets throughout the world. They can protect a seedling by fitting them over three large sticks. Just hammer three sticks into the ground around the seedling, and fit the sack on top like a glove. Make sure the sticks are sunk deep into the ground, so that passing livestock do not knock them over if they use the tepee to scratch their heads with. Just a few inches of wire to bind the sack to the stakes will hold the sack in place until the next rainy season. Sacks also provide shade from harsh dry season sun and winds, as well as protection from many large insects (grasshoppers, locusts, beetles).

- Any protection constructed around seedlings should be checked periodically for damage from sun and animals.

- Sticks and thorns can also be used to protect individual trees. If chicken wire or sacks are not available or are too expensive, thorny branches can be woven in between stakes and sticks.

- Farmers have also claimed success in sprinkling hot pepper, rotten milk, and livestock urine on seedlings to send an instant chemical message to animals.

- There are also numerous products on the market such as repellents and plastic seedling covers, many of which can be expensive. We recommend trying some of the methods mentioned above; the most important thing is to use local resources creatively.

Module 12: Life After AFFS

Objectives

- To work with famers to plan an activity (event/ceremony) that marks the end of the formal AFFS session and recognise the time and contributions of the AFFS members
- To motivate AFFS participants to plan and continue group activities after the first cycle of AFFS
- To promote the creation of linkages between the field school and donor initiatives and local and regional support agencies

Supplies

Ball, Markers, Flip Chart

Preparation

- Before this meeting review the *Agroforestry as a Business* section of this manual; and
- Review any forest or watershed management plans developed that include the community.

Venue

Shaded area with the demonstration plot or other field; neighbouring Church hall.

Total Time

3 hours

ACTIVITIES

Activity 1: Ending the AFFS Cycle (Graduation)

a. Facilitator should administer the post-AFFS quiz to participants in collaboration with external assessors.

b. Following the evaluation, farmers and facilitators meet to plan an activity that marks the end of the AFFS session with the farmers.

1. Have the group brainstorm on ideas for the end of AFFS ceremony and nominate a graduation planning committee.

2. Establish AFFS award categories (see Handout 1).

3. The facilitator should identify awardees and submit this list of names to the coordinating organization.

4. The facilitator should also brainstorm with the group on key lessons learned as a group that can be shared with the community and other representatives at the graduation event.

Activity 2: Developing a post-AFFS Group Plan

Group continues to meet and make medium and long term plans such as registration in benevolent or cooperative society or integrate into existing institutions.

a. Have group members refer to the D&D for the group's demonstration plot.

b. Facilitate a discussion towards agreement among the members about:

   1. Activities they would like to do with the agroforestry plot after the AFFS in the medium, short and long-term

   2. Have agreement on how the profits from the group will be managed to sustain the plot and provide economic and environmental benefit to the group and the community

   3. Are there environmental (forest or watershed) plans governing the area? Should the group's efforts be linked with other on-going efforts?

      - Does the group want to start a 2nd generation AFFS supported by some of the lead farmers from the group?

      - Is there opportunity for funding from groups such the Forest Fund and other small grants programs?

      - Does the organization (e.g. Forestry Department) have specific criteria that the group needs to review together?

Activity 3: Linking your Graduate AFFS Group to Existing Institutions for Leverage

c. Does the group want to join and existing group (for example):

   1. Farmers Groups: JAS, Coffee Board, Cocoa Board, Jamaica Cocoa Farmers Association

2. Watershed Management Committee

3. Local Forest Management Committee

4. Benevolent Society

OR

d. Does the group want to become registered? If so, who should the group consult with to complete this process (see Handout 3)

Handouts

Facilitator's Resource

Handout 1: Sample of AFFS Graduation Event Award Categories
Handout 2: Sample FFS Graduation Program
Handout 3: Get Your Facts on Friendly Societies

HANDOUT: Facilitator's Resource

The sustainability of the AFFS initiative at the group level is ensured in a number of ways: demonstrated economic return on the AFFS investment, group strengthening around a cooperative post-AFFS activity, and the opportunity for members to become leaders in their communities. Specific considerations for sustainability at the group level include:

- A mixed age composition;
- A constitution to strengthen its leadership and management;
- Designated officials and strong leadership;
- Formalization of groups and legalizing their status;
- Networking among groups and formal farmer field school networks;
- Cooperative commercial activities (e.g., livestock, beekeeping) and that provide good returns for the group;
- Savings systems;
- Group investments that ensure that farmers have a financial stake in the AFFS demonstration plot; and
- Cost sharing of activities and farmers' contributions to opening bank accounts.

Conducting your Post AFFS Evaluation Session

- During this closeout AFFS session the follow-up baseline survey should be administered to participants.
- The survey should be designed to capture changes in knowledge of and adoption of best practices in agroforestry innovations and climate change adaption measures.
- This session should also provide an opportunity to gather feedback from the farmers about their AFFS experiences.
- Field evaluation exercises that give participants the opportunity to demonstrate skills acquired in AFFS can also be considered.
- Finally, the Adoptometer (used on the CocoPal project in the Philippines) can also be administered. This is a data collection tool used to capture self reported adoption of best practices in FFS.

Key Consideration in Planning for *Life After AFFS* with Your Group

- During this session the facilitator should help to guide the participants in discussing what to do next after the AFFS curriculum has been completed.
- AFFS participants should be encouraged to continue group work after the curriculum has been completed.
- Group activities such as work days, group marketing, bulking purchasing and working towards registering the group as a benevolent society, LFMC, PMO or a JAS branch should be considered where possible.
- Where possible AFFS groups can also be linked to existing organizations such as the FD or JAS.
- The formation of structured alliance with neighbouring AFFS groups should be considered. This can ultimately lead to the development of regional and national AFFS networks.
- Members of the AFFS group can also assist in the mobilization and facilitation of new or the second generation AFFS

Planning Your Graduation Ceremony

- Criteria for awarding AFFS certificates to participants should be clearly outlined during AFFS sessions.
- Attendance of 70 % of AFFS sessions are recommended for awarding certificates to AFFS members.
- Graduation marks the end of AFFS curriculum and the recognition of the achievements by participants and the contributions of the facilitators.
- For many AFFS members this will be their first graduation and therefore this ceremony creates a great sense of pride and achievement to them.
- Graduation activities should be planned in collaboration with AFFS participants, support institutions, facilitators and other stakeholders.
- The support institution should especially lead in the preparation of graduation scene setter, talking points, graduation program, certificates and communication with program speakers
- T-shirts for AFFS graduation are normally done; this should provide a sense motivation for the graduates and help to foster better group cohesion especially after graduation.
- The participants will nominate special guests and speakers for the graduation ceremony.

- The graduation ceremony should also act as a forum to pass on lessons learnt in the AFFS to the general public.

- Participants should also be encouraged to display produce or outputs grown during the AFFS. This can also be complemented with short power point, DVD or drama to depict AFFS activities for the public to understand.

- Exhibition of value chain partners' goods and services should be considered at AFFS graduations. The following government agencies have mounted display booths at FFS graduations in the past:

  - ✓ National Insurance Scheme (NIS)
  - ✓ National Health Fund
  - ✓ Rural Agricultural Development Authority
  - ✓ CIB
  - ✓ JAS

HANDOUT 1: Sample of AFFS Graduation Event Award Categories

AWARD CATEGORIES

1. ***BEST ATTENDANCE***

   FFS grandaund who attended the most FFS sessions as documented in Facilitator's register.

2. ***OUTSTANDING LEADERSHIP***

   a. FFS graduante who gave the best support to the facilitator in terms of:

      - Farmer mobilization; and
      - Preparation for FFS sessions and general logistics for meetings.

   b. Empowered farmer with the ability to conduct farmers' meetings without the facilitator

3. ***BEST TECHNOLOGY ADOPTION***

   a. FFS graduand who best transferred and implemented learnt technology to his/her farm such as;

      - Soil erosion control;
      - Windbreaks; and
      - Shade management.

4. ***OUTSTANDING PARTICIPATION***

   a. FFS graduand who demonstrated the greatest spirit of cooperation and participated freely and willingly in all FFS activities.

This graduand truly embraced and applied the core principles of FFS and adult learning such as; sharing of experience, farmer to farmer diffusion and discovery learning.

5. ***BEST KEPT FARM***

   a. Farmer with farms that consistently displayed;

      - Good cultural practices, disease and rodent control;
      - Timely pruning practices; and
      - Increased production through FFS interventions.

HANDOUT 2: Sample FFS Graduation Program

Programme

Moderators

***Karyll Aitcheson**, Chief of Party, ACDIVOCA/Ja REEACH Project*
***Percival Shaw**, Parish Manager, RADA Clarendon*

Seating of Graduands	**Dean Passard/FFS Facilitators**
National Anthem	
Prayer	**Sidney Benjamin**, FFS Member
Greetings	**Denise A. Herbol**, Mission Director, USAID/Jamaica
Charge to Graduands	**Mort Neufville**, Chairman, ACDIVOCA
FFS Dramatization	**St. Thomas FFS**
Introduction of the Keynote Speaker	**Dianne Dormer**, Technical Assistance Director, ACDIVOCA
Keynote Speaker	**The Hon. Roger Clarke**, Minister of Agriculture and Fisheries
Item	**Stanley Smith**, Brandon Hill, FFS
Presentation of Certificates and Awards	
Farmers	**Minister of Agriculture & Fisheries**
	USAID
Facilitators	**ACDIVOCA HQ**
Blessing of Graduates	**Rev. Michael Cunningham**
Graduates' Response	**Victor Russell**, Wood Hall FFS
End of Program	

HANDOUT 3: Get Your Facts on Friendly Societies

Societies Registered under the Friendly Societies Act

There are three types of Societies that can be registered under the Friendly Societies Act of 1966:

1. Friendly Societies
2. Benevolent Societies
3. Specially Authorized Societies

Friendly Societies

A Friendly Society is established to facilitate assistance to members, their relatives and dependents in one or more of the following ways:

1. The relief or maintenance of members, their families and relatives during sickness, old age or on becoming a widow or orphan;

2. Insuring money to be paid:

    - On the birth of a member's child;
    - On the death of a member;
    - For funeral expenses of a member's dependent;
    - As relief during unemployment or distressful circumstances;
    - Against fire for tools or implements used by a member in his trade;
    - Against fire for household furniture; and
    - In the event of marriage of a member.

Two major examples of these Societies are Burial Schemes and Lodges.

Benevolent Societies

These Societies are largely community based organizations established for Benevolent or Charitable purposes such as:

- Creation of community development activities;

- Facilitate representations and recommendations to the relevant authorities for the improvement of the community infrastructure;

- Promote, assist and support the creation of healthy life styles and a high standard of family life;

- Foster the creation of job opportunities via skills training.

These Societies exist mainly in the form of Community Development Action Committees (CODACS) fostered by the Drug Abuse Secretariat to assist in the fight to reduce the incidences of substance abuse; Citizens' Association and charitable organizations aimed at community development, and entities such as Clarendon Association of Street People (CLASP) which provides care for the mentally ill in Clarendon and Water Users Societies aimed at bringing domestic water to their communities.

Specially Authorized Societies

These Societies can be established for any purposes other than banking with the authority of the Minister under whose portfolio the Department falls,

Features of a Societies Registered Under the Friendly Societies Act

- It is an organization established for business, civic, benevolent or charitable purposes.
- It is owned by the members who make all the decisions.
- It is democratically controlled; that is qualified members have an input in the making of decisions.
- It provides a service to the members, designated individuals or organizations.
- A Friendly Society is also a means of adult education, as a member through his Society can be taught better health care, nutrition or various other social skills.

For a Friendly Society to be Successful there are Certain Basic Requirements

- Members must have a common need.
- Members must be dedicated to the task of assisting be it for the community or for selected persons.
- Members must assist by financing their Society (through dues, fund raising, donations, etc.)
- The Society must have good leadership and proper management.
- Members must support their Society.
- Proper accounts must be kept of all financial transactions.
- Members must have the will and desire to better themselves, or to create the opportunities for others to better themselves.

Principles of Friendly Societies

Societies also operate under certain principles, these are:

Open and Voluntary Membership

Friendly Societies are voluntary organizations, open to all persons able to use the services and willing to accept the responsibilities of membership, without gender, social, racial, political, or religious discrimination

Democratic Control

Friendly Societies are democratic organizations controlled by their members, who actively participate in the setting of polices and making decisions. Men and women serving as elected representatives are accountable to the membership.

Members Participation

Members contribute to the funding of their Societies, through dues, donation, contribution, etc. Members contribute to the development and expansion of their Societies through pooling of resources, human, cultural or as is otherwise necessary.

Autonomy and Independence

Friendly Societies are autonomous; self-help organizations controlled by their members. If they enter into agreements with other organizations, including governments, or raise funds from external sources, they do so on the terms that ensure democratic control by their members and maintain their autonomy.

Education, Training and Information Friendly Societies provide education and training for their members, elected representatives, managers, and employees so that they can contribute effectively to the development of their Societies. They inform the general public – particularly, young people and leaders about the nature and benefits of co-operation.

Concern for Community

Societies work for the sustainable development of their communities through policies approved by their members; and collaboration with government and non-government organization which can assist with their overall development.

Advantages

The main advantages are:

- The Society is managed by the members (i.e. the Committee of Management and members are the major decision makers within the Society).

i. Members share in making the decisions at Annual General and other meetings. People are provided with the opportunity to pool their effort and skills to help themselves in a number of ways. It is an investment of the self, that is, 'for my own improvement", or the improvement of my fellowmen.

ii. The members make the Rules for the operation of the Society in accordance with the Friendly Societies Act, or any other Act that may infringe on the activities of the Society.

- Continuous education is provided.
- Management is participatory.
- Decision-making is participatory.

Statutory Obligations

- All Registered Societies are empowered to make and amend their Rules (Sections 10 & 11 of the Act). Such Rules shall be binding upon all members of the Society and contain all provisions stipulated in Regulation 3 of the Friendly Societies Regulations.
- Every Society shall have a Registered Office to which all communications may be sent (Section 20 of the Act)
- Every Society shall display its registered name legibly, in a conspicuous position outside its' place of business (Section 21 of the Act)
- No later than January 31 in every year every Society shall send a Return of the members and investments to the Registrar for the year ending December 31st preceding, showing:

  i. The number of members on roll, including every person who at any time during the year was a financial member;

  ii. The amount of money in the bank account of the Society;

  iii. The amount of money invested in stocks, shares or debenture of any bank or building Society in Jamaica;

  iv. The amount of money invested in real estate;

  v. The amount of money invested in shares in any Co-operative or authorized trustee securities

  vi. The amount of money in the Treasurer's hands at the close of the 31st day of December. (Section 22 of the Act)

- Full and proper Minutes of all Annual, Regular, Special and Committee meetings must be kept (Regulations 4)

- At least fourteen (14) days' notice must be sent to members for all Special Meetings; or the alternative if notice is published once a week in a daily newspaper circulating in the Island of Jamaica during at least two consecutive weeks prior to such meeting (Regulations 7).

- The Registrar shall audit or cause to be audited by some person authorized by him, the accounts of every Society at least once per year. (Section 23 (1) of the Act)

- The Secretary of every Society shall prepare a list of documents to be supplied to the auditors (Regulation 29)

- Every Registered Society no later than May 31 in each year shall send a return to the Registrar, known as the Annual Return. This Return shall show separately all receipts and expenditures of the Society. (Section 24 (i) of the Act)

- The Registrar may require every Society at least once in every five (5) years to submit a Quinquenial valuation which includes:

    i. valuation of the assets and liabilities of the Society by a valuer, who shall be appointed by the Society and approved by the Registrar;

    ii. a Return of the benefits assured and contributions received from all members and the debits and credits of all accounts accompanied by evidence in support there of as the Registrar may require (Section 25 of the Act)

- It shall be the duty of the Secretary of every Society to supply the auditors for the purpose of the Annual Audit with a certified list of the amount of contributions, levies and fines in arrears in respect to every individual member. (Regulations 20)

- The Committee of Management of every Society shall cause proper books of accounts to be kept. (Regulations 22)

- The Committee of Management shall present yearly to the General Meeting a statement of Account in respect to the operation of a loan fund, if any, showing the loan outstanding, deposits on hand, installments or repayments due and unpaid, the action proposed to be taken in case and a general review of operation of the said fund. (Regulation 25)

- A book shall be kept for the purpose of recording all levies imposed upon members by a Society during each year. (Regulations 39)

- Every bond shall upon execution be filed in the office of the Registrar without payment of a fee. (Regulations 42)

- Every Registered Society shall keep a copy of the last Annual Balance Sheet and the last Quinquennial valuation together with any special report of the prescribed persons, always posted in a conspicuous place. (Section 26 of the Act)

- Every Society shall supply members with copies of the Rules of the Society at a cost to the members (Section 31 of the Act)

- Every society shall on the application of any member interested in the funds of the society supply to that member:

    i. Copy of the last Annual Return of the Society.

    ii. A Balance Sheet or other audited documents containing the funds and Effects of the Society. (Section 32 of the Act)

- Every Society shall keep a book known as the list of pensioners to record the name, age, address, and reason for the declaration of pensionable status for every person declared a pensioner by the society. This book shall be kept opened at all times for inspection by the member at all reasonable times without payment of a fee. (Regulation 47)

When Is A Group Ready For Registration?

A group is only regarded as being ready to be registered when it can meet the following minimum requirements:

- Have defined objectives and is able to offer benefits to its members and the wider community.

- There is a genuine desire by the members to see the Society established and at least twenty-one (21) persons must have been enrolled in the membership.

- There is sufficient number of members showing a good general understanding of the principles and practices as well as the proposed Rules of the Society. These members should be able to satisfy the Department of Co-operatives at an evaluation of their understanding of Friendly Societies Act and the proposed Rules.

- The Committee of Management should be able to demonstrate a clear understanding of their role in the management of the Society and the procedures necessary to conduct a socially acceptable Society.

- An appropriate accounting system has been established. The system should be standardized as far as possible.

- There must be a secured office with the relevant furniture, facilities and personnel for the operation of the Society's business.

Conditions of Registration (Section 6 of the Act)

- A Society shall not be registered under the Friendly Societies Act unless it has twenty-one people. (Subsection 1)

- A Society shall not be registered under this Act under a name identical with any other existing Society registered or so nearly resembling such name as to be likely to mislead the members or the public as to its identity. (Subsection 2)

Protecting Lives and Livelihoods

For more information please contact the:

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