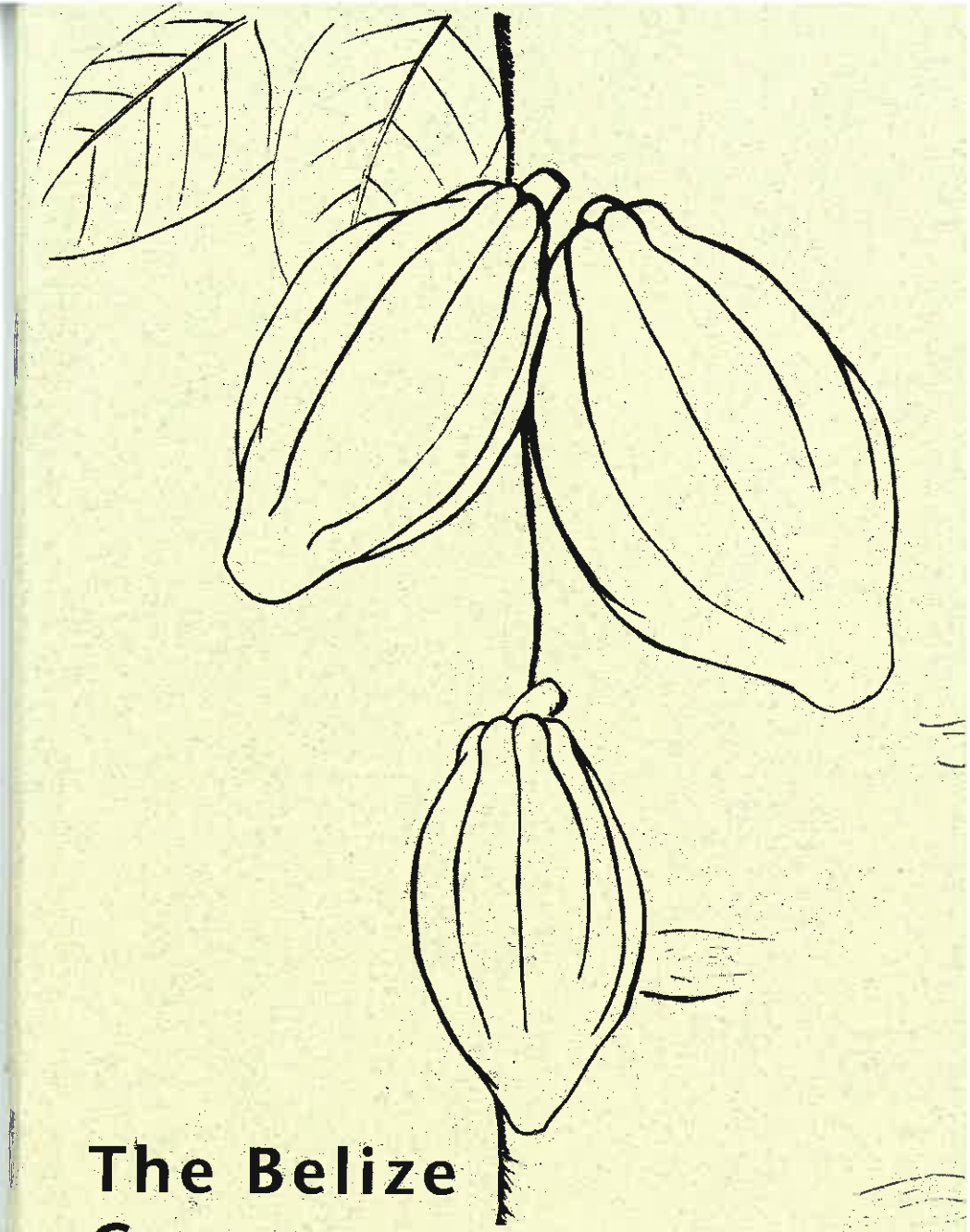

The Belize Cacao Agroforestry Handbook

BFREE

BELIZE FOUNDATION FOR RESEARCH & ENVIRONMENTAL EDUCATION
http://www.bfreebz.org/

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The rainforest is our classroom!

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ENVIRONMENTAL STUDIES

BFREE would like to thank Dr. James Rotenberg of University of North Carolina, Wilmington and his students who contributed to the development of this handbook. Special thanks also to Ms. Annelle Holder John of the Cocoa Research Centre, University of the West Indies in Trinidad for her valuable technical edits.

This book is dedicated to the cacao farmers of Belize with the hopes that they will continue to promote environmentally-friendly practices for the future health and the conservation of Belize's tropical forests.

For further information, visit
www.bfreebz.org or email contact@bfreebz.org

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Background and Context

This section of the handbook provides a brief history of cacao, defines and describes agroforestry, and explains the importance of protecting birds and other wildlife in Belize.

Preparation

This section details the preliminary planning and preparation process when starting a new agroforest or switching from an open-sun monoculture method to a shade-grown method. It will cover the basic steps of starting your own cacao-based agroforest.

Planting

Topics covered in this section include planting materials that are used, tips on planting seeds, growing seedlings successfully, a brief description of grafting and recommendations for transporting your seedlings.

Maintenance

This section of the handbook will cover general maintenance and good pruning methods on your farm and in your nursery. These methods are intended for a chemical-free farm. If you are interested in an organic farm certification one day, please keep in mind some maintenance methods may need to be changed.

Harvest and Post-Harvest

This section of the handbook will familiarize you with the harvest and post-harvest process including safe removal of pods from the trees to ensure continued production, fermentation, drying and storage. This section also introduces you to various pests and diseases that may occur in cacao-based agroforests.

Recommended Resources

Recommended resources includes information about organic certifications, a recipe for lime-based whitewash, a list of tools and supplies, a cacao cultivation record and further readings.

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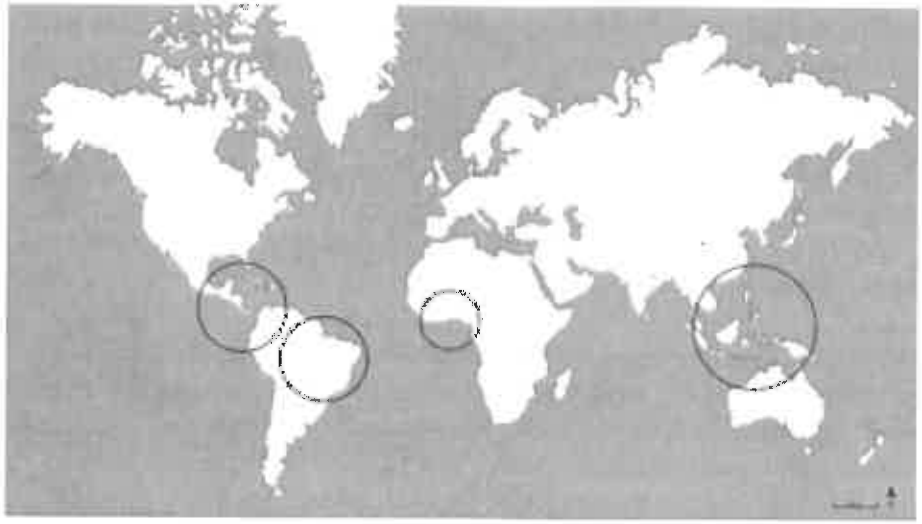
preface

The Belize Foundation for Research and Environmental Education (BFREE) was established in 1995 to conserve the biodiversity and cultural heritage of Belize. BFREE's biological field station is situated on 1,153 acres of privately owned land in the Toledo District, Belize's southernmost district, and adjoins the Bladen Nature Reserve and three other government protected areas. The field station provides a base for local and foreign scientists, as well as students to carry out research and educational activities.

Published by BFREE, this handbook was partially funded by the United States Fish and Wildlife Service (USFWS) on behalf of the Nyanza Natural Resource Damage Trustee Council—comprised of the USFWS, Commonwealth of Massachusetts, and the National Oceanic and Atmospheric Administration (NOAA), through a superfund settlement for mercury contamination that severely damaged migratory bird summer breeding habitat. The portion of the superfund settlement designated for restoring the migratory bird habitat in Massachusetts includes funding for restoration and conservation of the birds' winter habitat in southern Belize. By using a portion of the settlement to fund cacao-based agroforestry, the USFWS hopes to increase the numbers of affected species by restoring both winter habitat in Belize and the nesting grounds surrounding the contaminated site.

The intention of this handbook is to encourage the development of cacao-based agroforestry and provide instruction to farmers on proper techniques for growing and managing a productive, environmentally friendly, and sustainable cacao farm.

background | *history of cacao*



Theobroma cacao originated in the Amazon rainforest of South America and has been cultivated for more than 3,000 years. Cacao only grows in the tropics, within 10° of the equator; therefore, it cannot be commercially grown in North America, Europe, or most of Asia.

Historically there were two types of cacao—"Criollo" and "Forastero." Forastero is mostly grown in Africa, and is strongly flavored, slightly bitter and able to withstand more severe climatic conditions. Ninety percent of all beans grown in the world are Forastero. Criollo is known for its fine, nutty flavor. A hybrid of the two varieties developed naturally when Criollo populations were devastated due to disease or severe weather conditions and Forastero types were later introduced. The Forastero trees crossed with the remaining Criollo trees and the hybrid group produced is called "Trinitario." The word Trinitario comes from Trinidad, which is one of the first place this hybrid was developed in the 18th century. Like Criollo, Trinitario is known for its fine flavor, and like Forastero, it is hardy. Most of the cacao grown in Belize is Trinitario, although Belize is home to a Criollo variety that was cultivated by the ancient Maya.

background | *history of cacao*

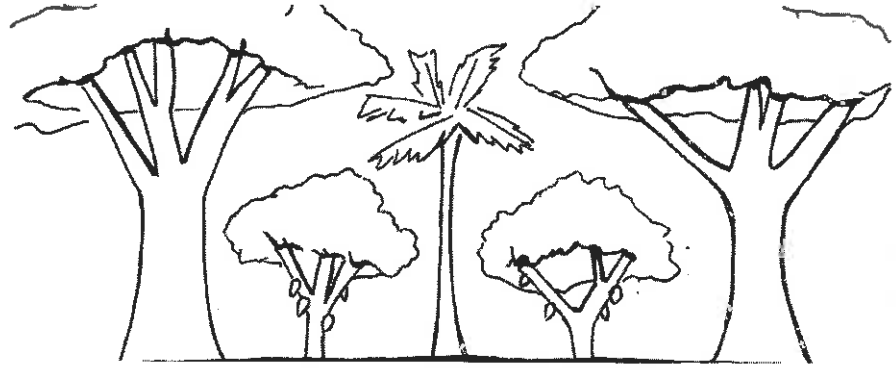
During the 1970s and 1980s, Belize's cacao economy boomed and the number of farms and the amount of cacao exported expanded substantially. The Hershey Company established a 500-acre farm in 1977 on the Hummingbird Highway and encouraged local farmers to grow cacao by agreeing to purchase all Belizean cacao at global market prices. However, declines in the global market price of cacao led to Hershey's exit from Belize in 1992. Deprived of a major market, most Belizean farmers converted their land to other cash crops, ending the cacao boom.

Most cacao is currently grown in Central Africa and Southeast Asia, but increased demand has expanded production of cacao to other parts of the world including Central and South America and the Caribbean. Belizean varieties are considered high quality, "fine flavour" and therefore can be sold for a higher price than much of the bulk cacao, commonly grown in Africa. The growing demand in the global market, in addition to an expected high return, makes this an excellent time for Belizean farmers to invest in cacao production.

Cacao grows well as an understory crop and does not require full sunlight to be productive. This characteristic, as well as cacao's status as a reliable cash crop, makes Belizean cacao an ideal base for an organic or a near-organic, chemical-free agroforestry system that can also include a variety of fruit and timber trees, coffee, and spices.

Since 2010, the Belizean cacao industry has expanded dramatically. The demand for beans has grown and there are a number of businesses that will pay cash for both wet and dried beans. Numerous small companies are now making chocolate products for local consumption and for the tourism industry. The cacao industry in Belize has the opportunity to improve the quality of people's lives and help preserve the environment for future generations.

background | *agroforestry*



What is agroforestry?

Agroforestry is a method of agriculture that involves planting a variety of crop species within a forest system. In Belize, a mature agroforest will look like a rainforest; diverse and full of life.

What are the benefits of a cacao-based agroforest?

A cacao-based agroforestry system retains much of the forest structure and many of the environmental benefits the forest provides, while also allowing the farmer to extract cultivated and non-cultivated resources from it.

Since an agroforestry system is ecologically balanced, expensive chemicals and fertilizers are not usually necessary because the birds and other organisms that live in your farm will keep insect pests under control, while the leaf litter and woody debris from the shade trees provides organic fertilizer.

Deforestation and slash and burn (milpa) practices release carbon dioxide into the atmosphere, which is a cause of climate change. Climate change is causing changes in weather conditions, such as drought, stronger hurricanes, rising temperatures and excessive rainfall. An agroforest stores carbon dioxide in its trees, which helps alleviate climate change.

background | *why cacao?*

Why establish cacao-based agroforests on your own land?

Maintaining a forested habitat benefits plants, animals, and people.

Benefits for your farm

- The same farmland can be continuously used.
- Forested land has a higher value.
- Drinking water is not contaminated by run-off from chemicals, fertilizers, and pesticides.
- Food nutrition is improved because of diverse crops.
- Clearing and burning the field is unnecessary in agroforests.
- Agroforests are typically more drought resistant.

Benefits for the wildlife and environment

- Agroforests attract natural predators, like birds, which feed on insect pests.
- Soil does not lose its fertility because nutrients are replenished by the thicker leaf litter provided by the other plants and trees. This thick mulch of leaves and plants also prevents the quick run off of nutrients during rainy periods.
- Diversified products provided food, habitat and corridors for wildlife.
- Timber and fruit trees can also be planted and harvested to provide income immediately and over the long-term.

background | *agroforestry & birds*

Migratory Birds and Agroforests

Cacao can be grown under a mixed forest that provides feeding and resting habitat for migratory songbirds and nesting habitat for resident birds. Migratory and resident birds are important for your agroforest because they help regulate insect pests, disperse seeds, and pollinate a variety of crops. They are also beautiful animals and they attract thousands of bird-watchers to Belize from around the world each year.

Typical crops in Belize are pineapples, bananas, corn, beans, and these cannot be grown under shade and therefore do not provide healthy habitat for birds or other wildlife.

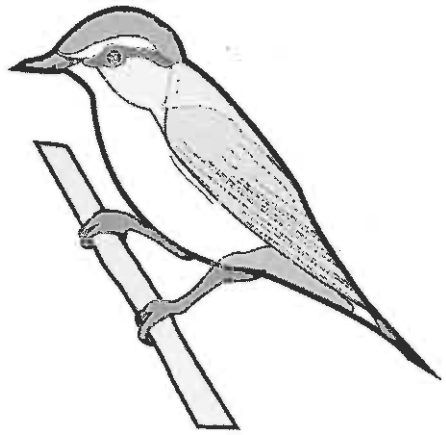


Image above: Red-Eyed Vireo

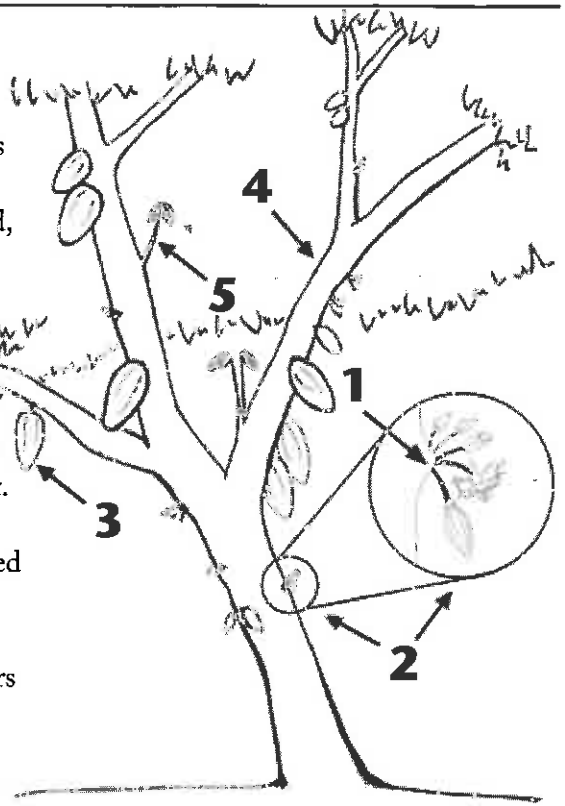
Birds in Belize

Belize is home to nearly 600 species of birds. 350 of those species are migratory birds, which are birds that migrate from their summer homes in North America to their winter home in Belize.

Migratory bird populations are in decline in large part due to habitat destruction from deforestation both in their summer and winter homes. Efforts are being made to protect these birds in North America, but the efforts will be unsuccessful unless the birds' habitat in Belize is also conserved and restored.

Some of the many species of migratory birds that benefit from habitat conservation in Belize are the Red-eyed Vireo, Yellow Warbler, Chestnut-sided Warbler, Northern Waterthrush, Grey Catbird, Least Flycatcher, Eastern Kingbird, Wood Thrush, and Kentucky Warbler.

background | *cacao tree basics*



1. The floral cushion is the area on the truck or branches where flowers grow from. If the floral cushion is damaged, it will not produce more flowers or cacao pods.

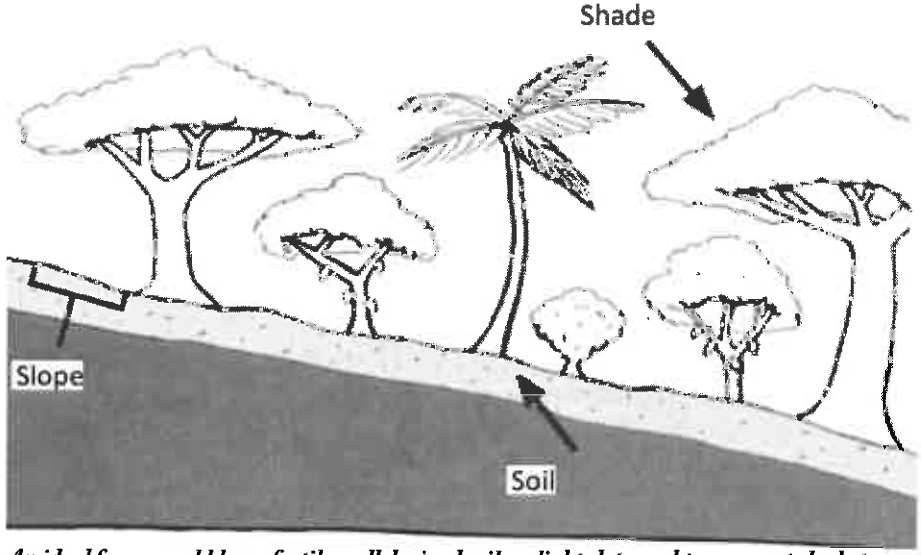
2. Cacao flowers grow from floral cushions on the trunk or branches. The small, white or pink flowers have no scent. They contain both male and female parts and are pollinated by gnats, flies and mosquitos. The amount of rain and sunlight affects how many flowers will grow.

3. The cacao pod is the fruit of the cacao tree. The pods vary in color which changes as the pod ripens. Most pods change from green to yellow or from dark red to red-orange. Inside the pod are 20-60 seeds covered in a white pulp.

4. Fan branches are the main lateral branches of the cacao tree. Only 3 or 4 strong fan branches should be retained.

5. Chupons are upright shoots from the main trunk or branches. Once the fan branches are established, new chupons should be removed regularly while they are young and green so they do not take energy away from the pods.

background | *farm suitability*



An ideal farm would have fertile well drained soil, a slight slope and permanent shade trees.

Is My Farm Suitable for Growing Cacao?

Before deciding to grow cacao on your farm, there are three things that should be considered: soil, slope and shade.

Soil: *The ideal soil should be rich, well aerated and limestone based. Make sure it is at least 150 cm deep. Cacao does not grow well in clay, or dry, sandy soil.*

Slope: *If possible, the piece of land should have a slight slope. This will allow water to drain off during the rainy season. Flatter land is suitable as long as there is good drainage.*

Shade: *Starting an agroforest is easier if the land already has some shade trees. Heavily forested land with large trees is not suitable, as the forest would need to be cleared substantially. Cleared land is suitable as temporary and permanent shade trees can be planted.*

NOTE: These factors describe the ideal land for growing cacao. If your land does not meet all of these ideal factors, you can still cultivate cacao, as it grows well under many varied conditions.

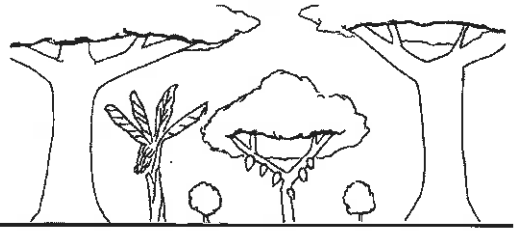
The three main agroforestry layouts are: **Alley Cropping, Terrace/Contour Planting, and Windbreaks/Living Fences.**

ALLEY CROPPING

Alley Cropping is used in Central American countries and involves having a thick tree canopy with smaller plants and crops in between the rows of large trees creating a polyculture system. Everything is planted from East to West to provide sunlight for the crops.

- *Provides both long-term and short- term crops.*
- *Row layout helps make harvesting simpler.*
- *Works best if you have flat, level land.*
- *Is a good design for shade-grown cacao or coffee.*

Suggested trees include: Annatto, Star Apple, Custard Apple, Soursop, Nutmeg, Coconut, Craboo, Jippi Jappa, Peach Palm.

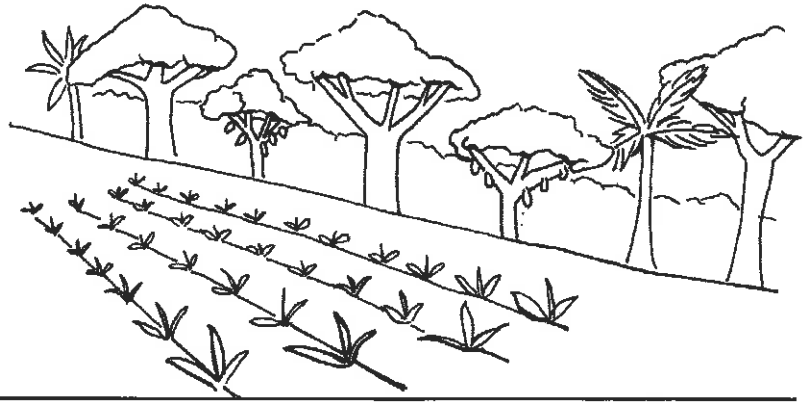


TERRACE PLANTING

- *Serves as a "living transition zone,"*
- *Allows a farmer to use land that may be considered undesirable due to the grade.*
- *System can be difficult to establish and harvest because it is on a hillside.*
- *System reduces erosion and runoff as compared to hillsides without plants.*

Terrace or Contour Planting involves planting both crops and shade trees on contour lines along a hillside. It is the best method of planting on steep slopes.

WINDBREAKS



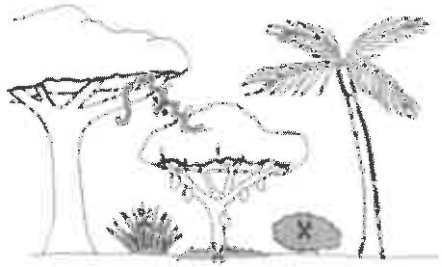
- A windbreak or living fence consists of an agroforest along a border. Once again, this system can be arranged into a polyculture.
- Windbreaks are best if your land borders another person's piece of land or a national park or nature reserve.
- Benefits of this system include reduced erosion and can act as a wildlife corridor in disturbed areas.
- This system is a good introductory technique for farmers who are new to agroforestry.

TIP: Trees like Inga (Bri-bri) may encourage wildlife and it is good for the soil.

TIP: For an organic farm, layout and location are important to keep in mind.

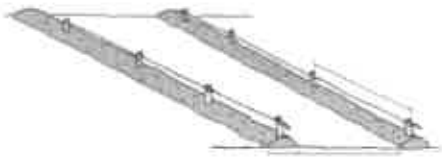
preparation | *ground*

Ground Preparation



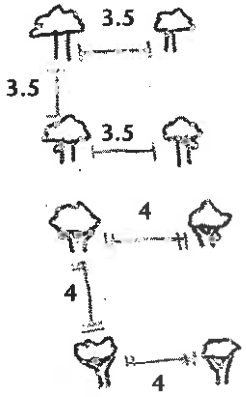
Using your machete, clear your land of underbrush, small bushes, vines, weeds or small trees. Chop up the underbrush and twigs and spread evenly over the ground to improve soil nutrients and quality.

Rows



Clear rows that are approximately 1 meter wide and 3.5 to 4.5 meters apart. Mark your rows using pegs and string. Line the rows with the string. Every 3.5 to 4.5 meters, place a peg indicating where a seedling will be planted.

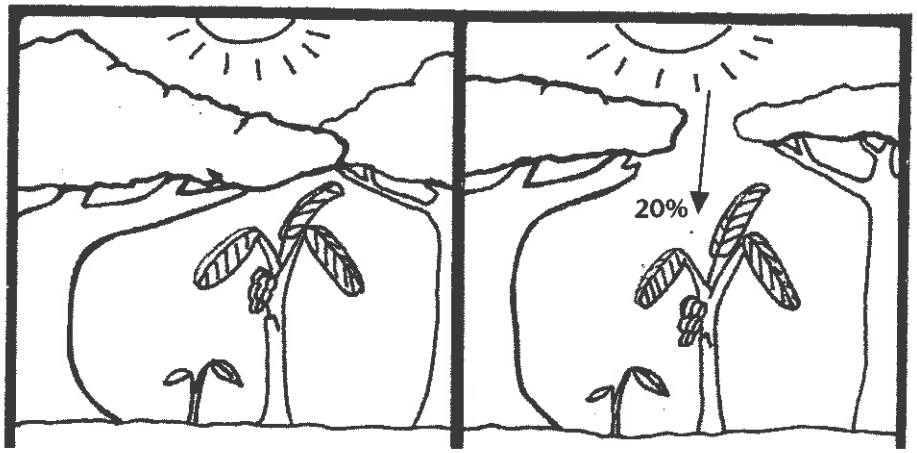
Spacing



There are many ways to space cacao trees on your farm. With more space in between your cacao, you will have more room to plant native timber and fruit crops.

- One acre will hold about 330 trees if you clear rows that are 3.5 meters apart and plant trees 3.5 meters apart.
- One acre will hold about 200 trees, if you clear rows that are 4.5 meters apart and plant trees 4.5 apart.

preparation | *canopy*

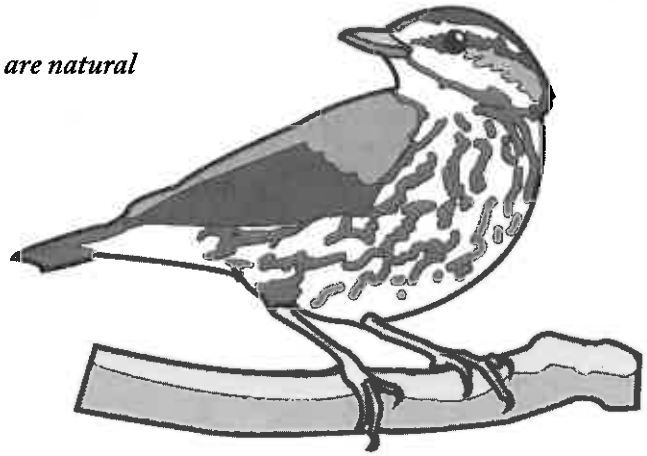


Canopy Preparation

Using your machete, thin the canopy so that it lets in 25-30% sunlight. Leave a variety of different trees. Shade trees help protect your seedlings from direct sunlight, strong wind, pests and diseases!

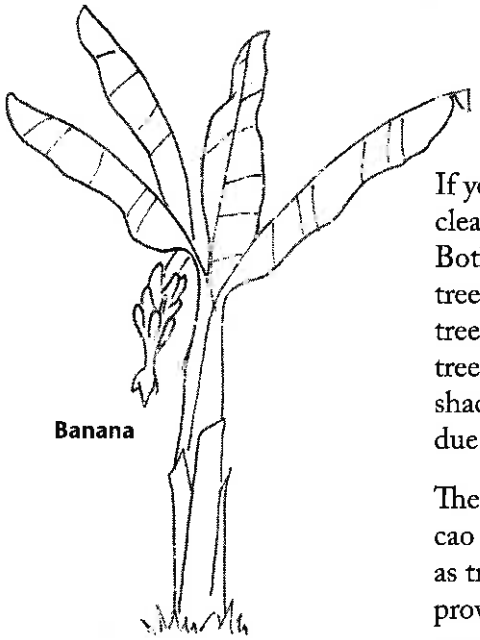
Shade trees also help recycle nutrients. A shaded environment provides habitat to birds and pollinating insects such as flies and mosquitos.

Remember that birds are natural pest removers!



Pictured right:
Northern Waterthrush

preparation | *shade trees*



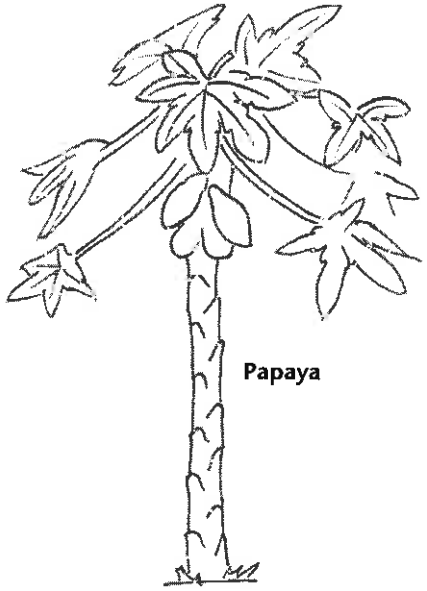
If you have to plant shade trees on cleared land, choose a wide variety. Both temporary and permanent shade trees are beneficial. Temporary shade trees provide cover until the cacao trees grow too big while permanent shade trees will always provide cover due to their size.

The extra shade required by young cacao trees should be gradually removed as trees mature. Permanent shade trees provide the cover that mature cacao requires for the life of the crop.

Some examples of temporary and permanent shade are given below:

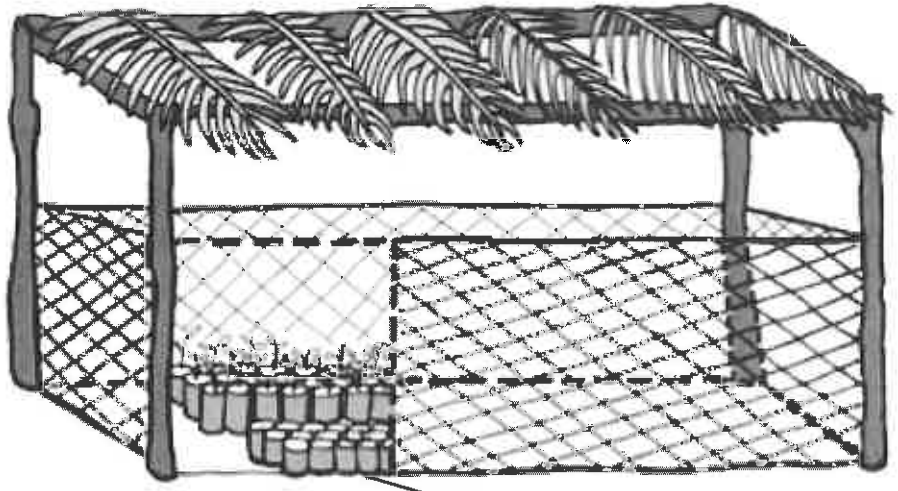
Temporary Shade: Plantain, Madre de Cacao, Banana, Papaya, and Pigeon Pea

Permanent Shade: Mayflower, Rosewood, Bukut, Avocado, Mammy Apple, Mally Apple, Bri-bri, Rose Apple, Golden Plum, Goose Berry, Balam, Black Sapote, Cedar, Mahogany, and Sapodilla



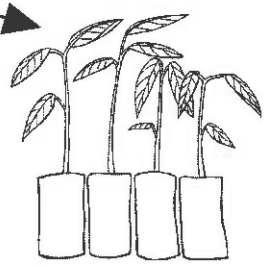
preparation | *nursery building*

Seedlings should be grown in a nursery before being planted in the ground. The nursery can be constructed with local, inexpensive materials, such as stick, cohune palm leaves, string, and fencing material.



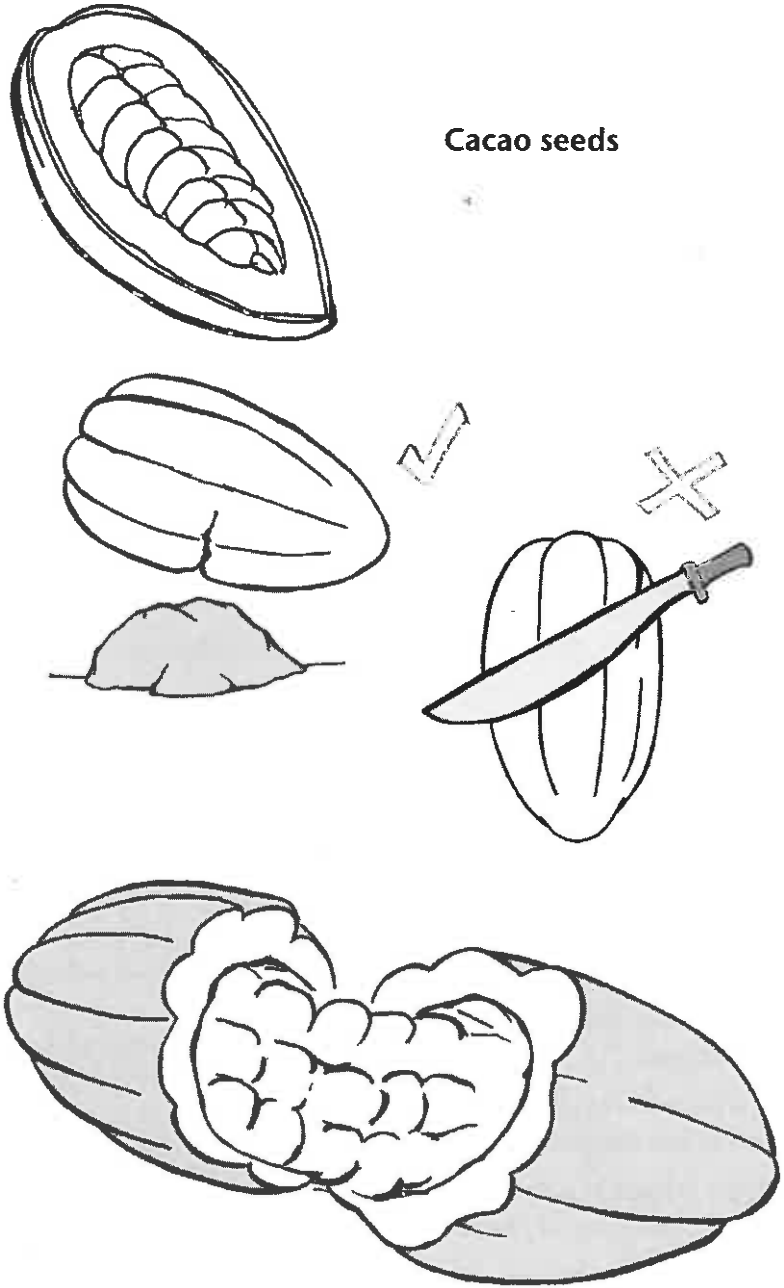
Constructing your nursery

- Place your nursery in an area where you can easily access water all year round.
- Frame the nursery with wooden posts and sticks.
- Attach cohune leaves to the top for shade. They should only allow about 25% of the sunlight through.
- Build a fence around the nursery to keep out animals like chickens and dogs.
- Seeds are planted in nursery bags, which are generally made out of plastic.



Place the bags closely together so they do not fall over. Create rows so you can easily maintain the seedlings.

preparation | *seed collecting*



Cacao seeds

preparation | *seed collecting*

Cacao seeds come from the inside of cacao pods and are covered in a sweet white pulp.

Select pods from mature trees that produce a lot of pods every year. Make sure that the trees and pods do not show any signs of disease or fungus. If you have local cacao farmers in your village, they may be able to help you collect and select seeds.

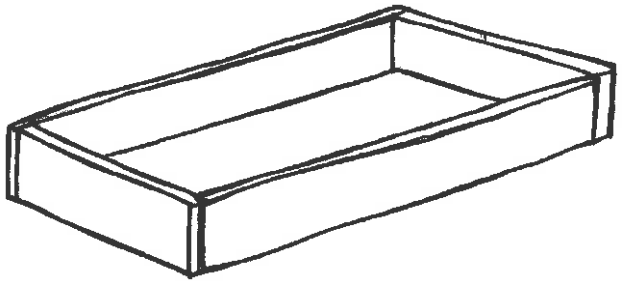
Once collected, crack open your pods against a rock, the ground or wood.

Do Not use a machete, as you may accidentally cut some of the seeds, and they will not germinate.

Choose seeds from the center of the pod rather than the bottom or top, as these seeds are usually the largest.

preparation | *germinating*

The seeds must germinate before you plant them in bags.



The best way to germinate cacao seeds is in a wooden germination box.

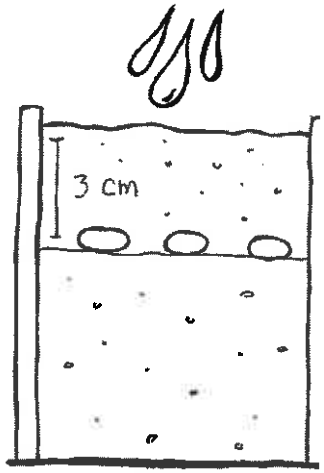
By using a box, you can ensure that the seed properly germinates and determine the correct position for planting.

You need four pieces of wooden board to build a germination box.
Two of the pieces should be long and two pieces should be short.

- Nail the pieces together to make a rectangular shape.
- Place the box on the ground.
- Use old sawdust or a mixture of half sawdust and half topsoil and/or rice hulls as germinating soil.

  Sawdust is preferred as it can hold more water than topsoil or rice hulls. Sand can be added as well to provide some drainage.

preparation | *germinating*



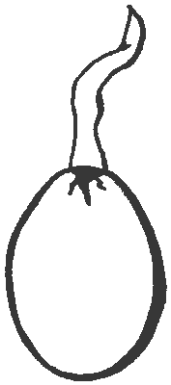
Fill your germinating box with at least 8 centimeters of germinating soil and moisten with water.

<u>Do Not</u> soak the soil with water, because the seeds may rot.

Gently place the seeds at least 3cm below the surface of the soil and make sure they are covered.

Allow the seeds to germinate for five to six days making sure the soil stays slightly moist.

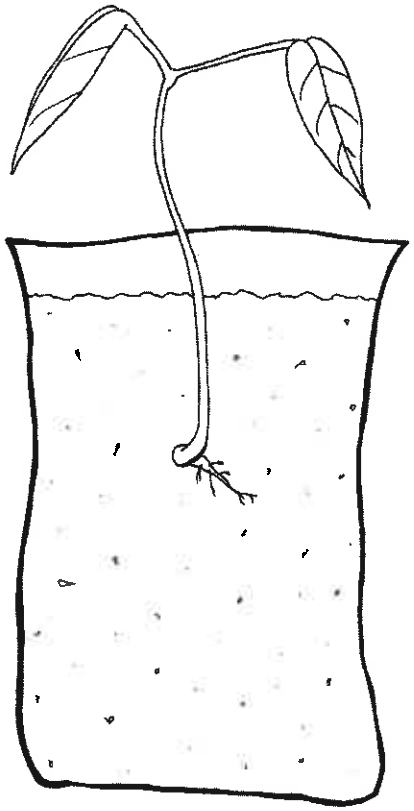
As soon as there is a sign of the shoot (a little white nub) you can transplant seeds into bags.



TIP: The longer you wait to transplant, the more developed the roots will become and the more likely the young roots can become damaged while handling.

planting | *planting seeds*

How to plant your seedlings



1

Fill the bags to the top with a mixture of half soil and half sawdust, rice hulls or sand. If the bag is packed too densely, then the seed will not grow easily.

2

Make a 4 cm hole in the soil. Put the pre-germinated seed in the hole, shoot side down and cover with the loose soil mixture.

3

Water the bag lightly. Too much water will make the soil compact and the seed will not grow easily.

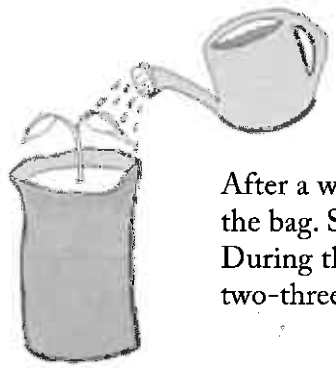
TIP: Line the bags up closely together so they do not fall. Leave passages between the rows of bags to allow for plant maintenance. Rows of 5 bags wide work well

planting | *growing seedlings*

Seedlings must be handled with care to ensure you will have strong, healthy trees in your agroforest. Never handle your seedlings by the stem as they are fragile and can break easily and the roots can be damaged.

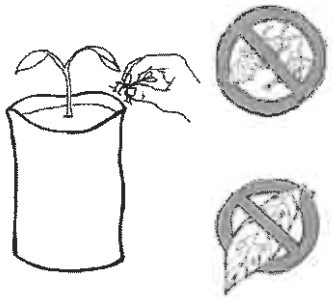
At first, your nursery should have about 70% shade. After two months, when the seedlings are about a 1/3 of a meter tall, remove some cohune leaves so that the shade is 50%. Too little sun can cause the seedlings to become weak.

Do not remove more than 70% shade! Too much sun can burn the seedlings.



After a week or two, a sprout should appear from the bag. Soak the bag with water once this happens. During the dry season water the seedlings about every two-three days.

Always monitor for pests and diseases. Do not forget to check under the leaves. Thrips, capsids, stem borers and caterpillars are very common and should be removed if seen.



Remove weeds from the bags.

Any seedlings infected with diseases such as root or stem rot or that have spots on their leaves from bacteria or fungi must be removed immediately. Destroy any infected seedlings.

planting | *grafting*

Grafting

Grafting is a technique used to join parts from two or more plants so that they appear to grow as a single plant. In grafting, the upper part (scion) of one plant grows on the root system (rootstock) of another plant. In the case of cacao trees, the cacao budwood is attached to existing rootstock.

Benefits

Grafting cacao trees can be beneficial because it changes the variety of the tree to create stronger, healthier plants.

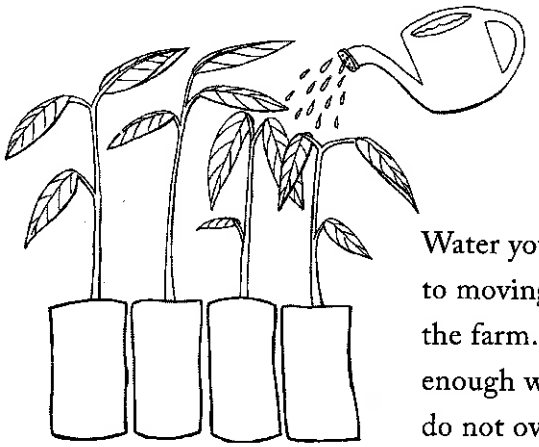
Grafted trees are created to be more insect and disease resistant, have better drought tolerance, and produce higher yields.

Types

"Patch" grafts and "Wedge" grafts are two common techniques used for cacao trees.

Grafting is a very technical process and requires training and practice.

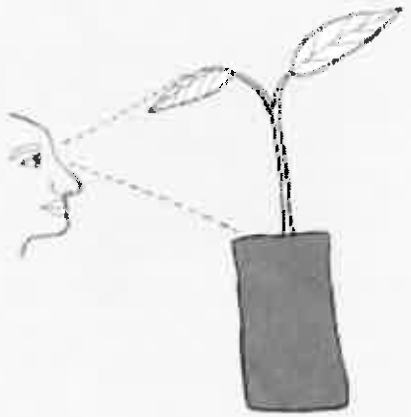
planting | *transporting seedlings*



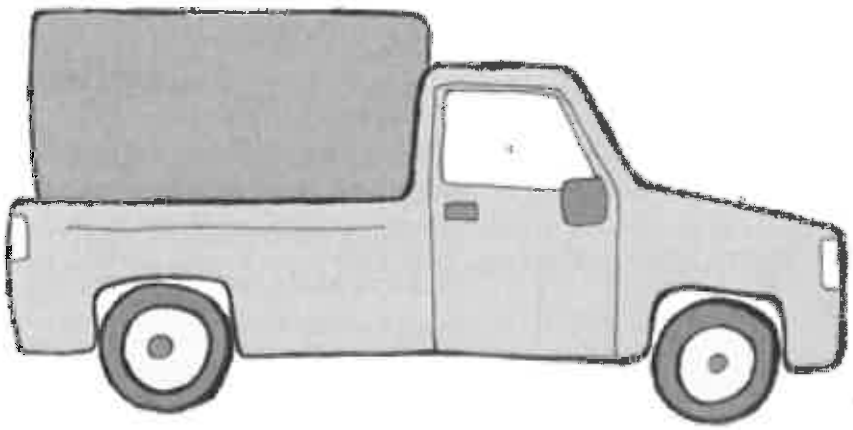
Water your seedlings one week prior to moving them from the nursery to the farm. Make sure they are given enough water to last a week, but do not overwater, because the soil mixture will fall apart when the bag is removed for planting.

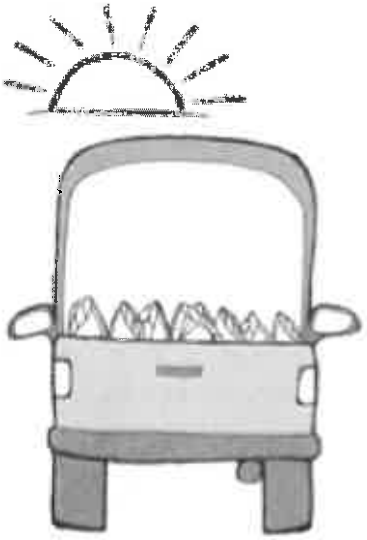
IMPORTANT

Before moving the seedlings to your farm, check that the seedlings do not have stem borers or disease. Destroy any infected seedlings before moving the seedlings to your farm to prevent your farm from being infected.



planting | *transporting seedlings*

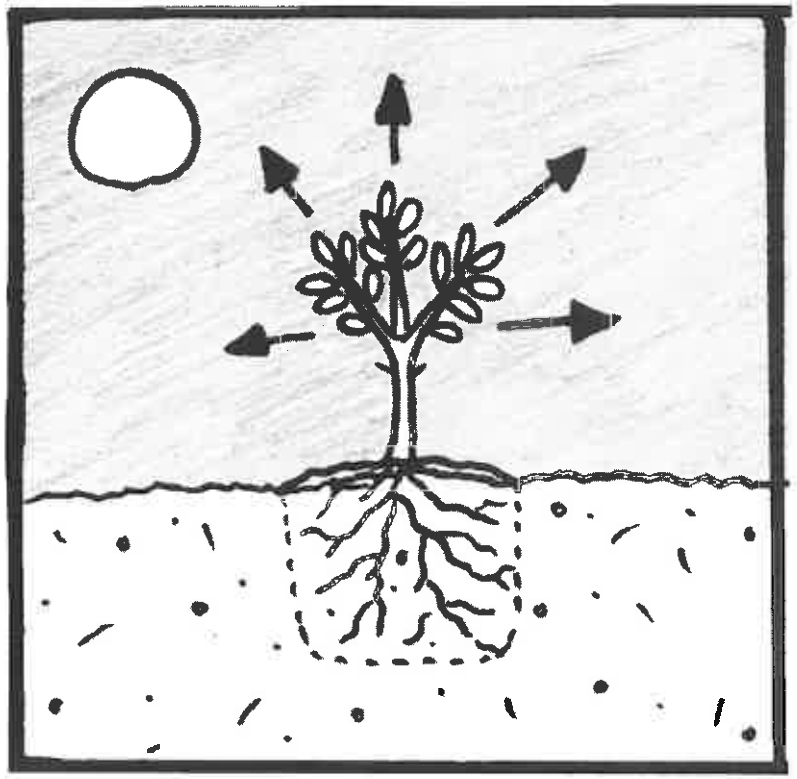




The seedlings should be moved the day before they will be transplanted, either early in the morning or evening. In the middle of the day, the seedlings may get windburned or sunburned. Use a closed vehicle when transporting, if possible.

Your seedlings are ready to be moved from your nursery to your farm when they are six or seven months old.

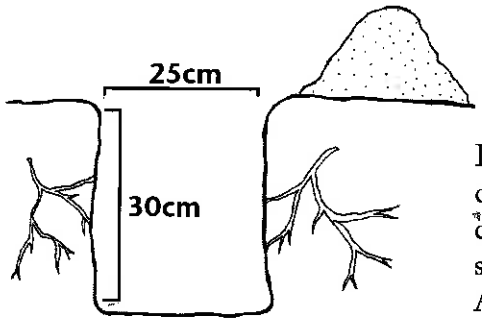
planting | *transplanting seedlings*



The lunar planting method works well in Belize as well as throughout the world.

To prepare for transplanting, first refer to a calendar that indicates the phases of the moon. Select the dates at the beginning of rainy season that are between two days before the full moon and two days after. By waiting until this time of year, you will ensure that the roots are developed enough to support the seedling during the dry season. The gravitational force of the full moon will draw a greater amount of water into the plant.

planting | *transplanting seedlings*



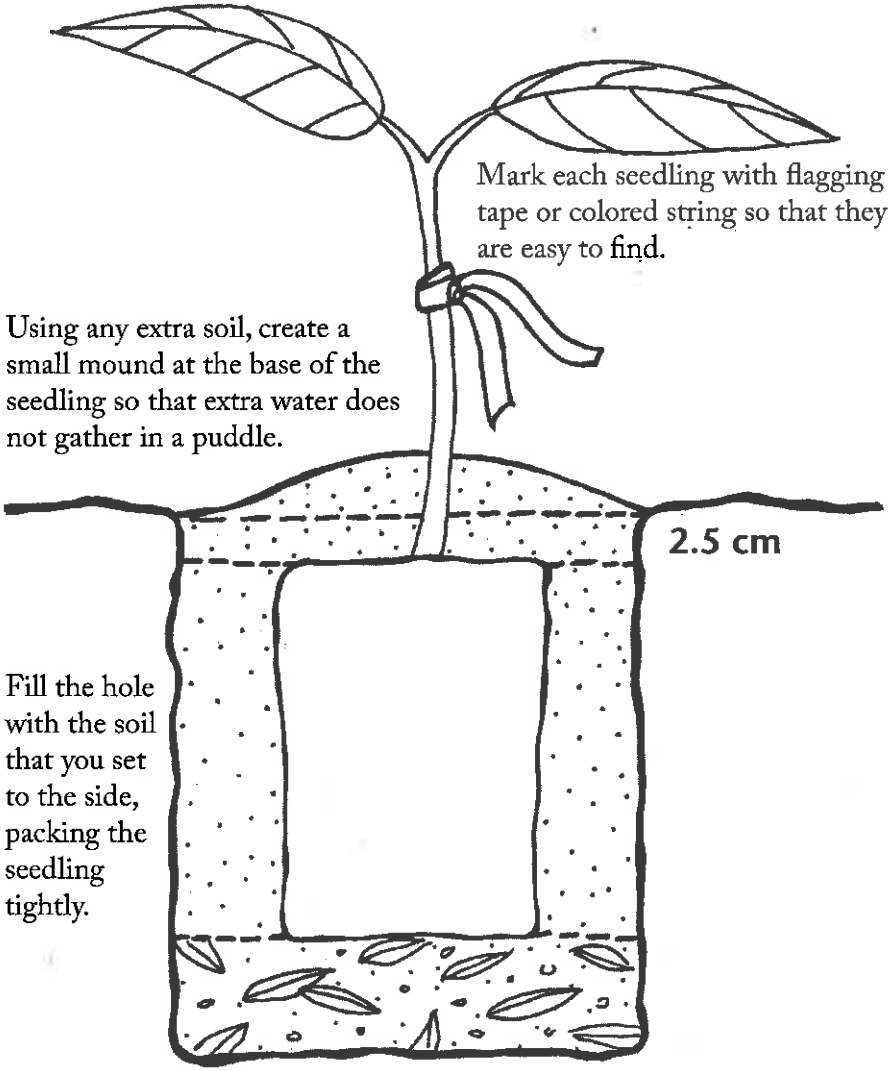
Dig a hole that is 30 centimeters deep and 25 centimeters across with a shovel or post-hole digger. Allow enough room for the soil to be loose around the seedling and to make it easier for the young cacao roots to establish.

Place the extra dirt beside the hole. Be certain all existing roots in the hole have been cut up and removed.

Do not dig the holes more than one day before you plan to transplant the seedlings.

IMPORTANT Handle the seedling and seedling bag gently during the planting process! Not doing so can damage the young plant. Carefully open the seedling bag either by tearing it open, or with a knife or razor. Do not loosen the soil.

planting | *transplanting seedlings*

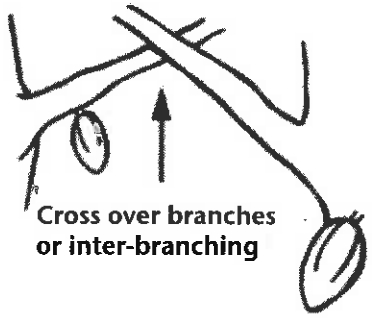


Fill 1/5 of the hole with topsoil and rotting leaves. Place the seedling in the hole. The top of the dirt from the planting bag should be about 2.5 centimeters below the surface of the ground.

maintenance | *vocabulary*

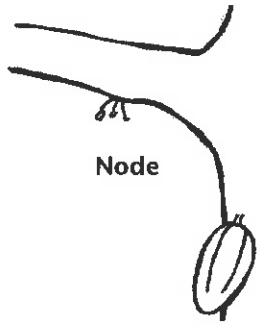
Cross-over Branches

Also called Inter-branching are branches from two trees that cross-over one another. The rubbing of these branches can introduce disease.



Node

A node is where a shoot arises. For older trees the term collar may more likely be used.



Nutrients

Minerals such as nitrogen and phosphorus that are necessary for growth and good health.

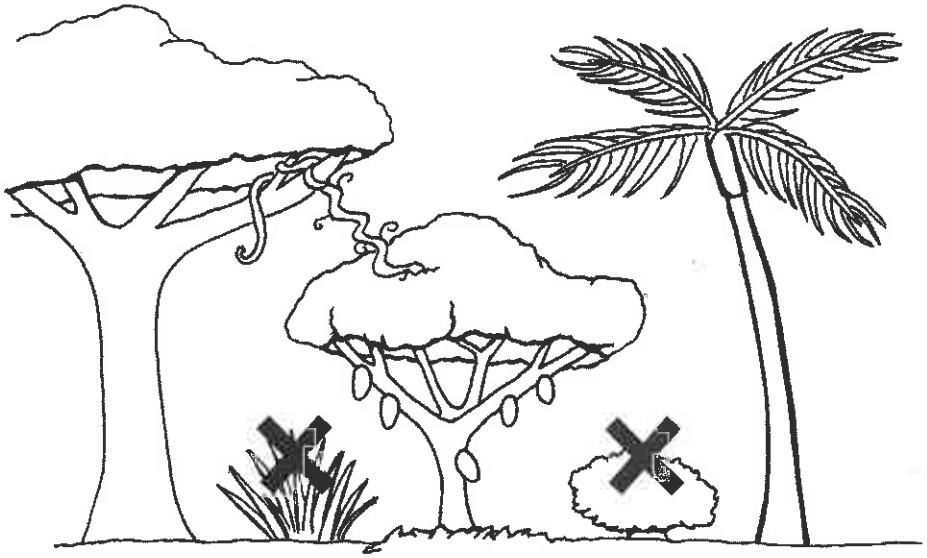
Sanitation

Removal of any disease or contaminants. This should be done to any tools prior to use by washing off residues, then pouring alcohol over the tools and allowing to air dry.

Lime-based Whitewash

A thick, white paint-like substance to be used during pruning. A recipe can be found in the Additional Information section.

maintenance | *prevention*



There are five main types of maintenance that must be done on a regular basis:

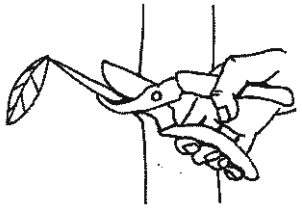
- **weeding**
- **preventing pests and diseases**
- **maintenance pruning**
- **structural pruning**
- **controlling the shade.**

Weeding

While your cacao trees are seedlings, the entire farm should be cleared of vines and weeds once during the rainy season and once during the dry season.

Once the cacao trees have matured the farm should be cleared of vines, weeds and small bushes once or twice a year. Remember that some of this leaf litter can be kept at the bottom of the trees to help nutrients recycle back into the ground. Once again, never burn the chopped bush.

Preventing Pests and Diseases

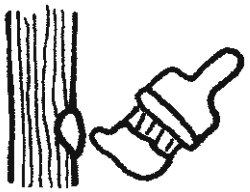


It is best to manage pests and diseases without chemicals. Remember, many insects may appear like pests, but may be important pollinators.

You can distract some pests by planting other fruit trees around your farm. Papaya and avocado trees will attract kinkajous, squirrels, rats and woodpeckers, which will keep them away from your cacao pods.

See page 57 for more information on pest and disease maintenance.

Pruning



During the dry season and early parts of the rainy season, mature trees should undergo maintenance pruning.

Maintenance pruning includes removing chupons as soon as they appear. Cut the chupons off with sanitized shears at an angle. If the chupon is bigger around than a pencil, apply lime to prevent pests and diseases from entering the tree. For a recipe for a white lime paste, see the Additional Information section.

Remove sick or dead branches or pods as soon as possible.

Managing Shade

Maintaining the correct amount of shade in your farm is critical. Too much sunlight causes trees to overgrow and become sun-burned, while too little sun can result in weak trees that grow slowly.

Seedlings in the ground need more shade than in the nursery, because they are watered by hand in the nursery. Seedlings also need more shade than mature trees since direct exposure to sunlight can be harmful.

When adjusting shade, do so in stages rather than all at once as to not shock the trees with too much sun. Be sure to make any adjustments to the amount of shade in your farm at the start of the growing season.

Keep in mind: sometimes cutting a few branches that block sunlight rather than removing entire trees is all that is needed to provide enough sunlight!

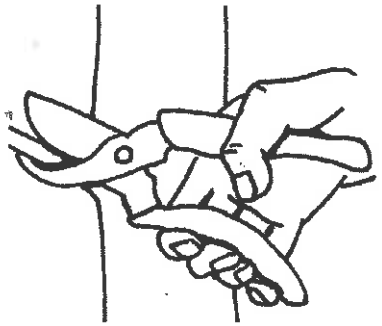
Shade Management Timeline

Time Frame (In Terms of Cacao Trees)	Shade Amount (%)
During Germination	75
As New Seedlings in Nursery	80
As Two Month Old Seedlings in Nursery	50
At Transplanting	80
After One Year in the Ground	65
After Two Years in the Ground	50
After Three-Five Years in the Ground	40-45

TIP: Never adjust the shade amount after flowers have appeared right before the dry season because some trees will lose their leaves and then too much sunlight will come through if you have adjusted the shade amount.

There are two important things to keep in mind when pruning:

- **the proper pruning method**
- **equipment sanitation**



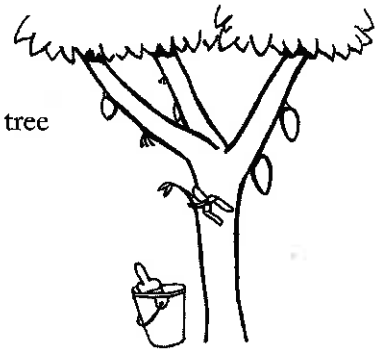
Proper Pruning Method

Structural pruning can be done with shears or a small handsaw.

Prune branches or chupons as close as possible to the node. The node is the point where the branch or chupon attaches to the trunk or another branch. Always make the cut at an angle.

Make sure to not damage other parts of the tree when pruning.

Never climb the tree to prune branches; the boots or shoes you are wearing will damage the tree. If the floral cushions are damaged, they will not produce pods. The tree branches can also become weakened or break.



Always apply lime-based whitewash to the tree after pruning.

Improper Pruning Methods

Bark Ripping: Bark ripping occurs when the chupons or branches are ripped from the tree. This can damage the tree.

Flush Cutting: Flush cutting occurs when the branches or chupons are cut too close to the tree and other parts of the tree are damaged in the process. This can introduce disease or prevent pods from producing.

Stub Cutting: Stub cutting occurs when the branch or chupon is not cut close enough to the node, and a stub remains. This will prevent the tree from healing quickly and can introduce disease.

Equipment Sanitation

Always sanitize your equipment regularly with alcohol. This will help prevent the spread of disease.

Do Not use the same shears you used to remove diseased pods or parts of the tree suffering from other fungi or bacteria until they have been properly sanitized.

It is best to have a machete or pruning shears that you use only on your cacao farm. This will help prevent potential diseases from other crops or plants from contaminating your farm.

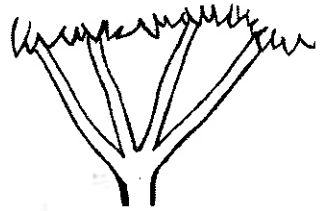
Use the Following Pruning Schedule

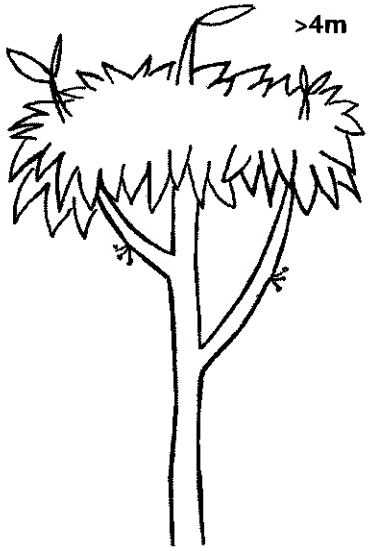
Seedling

A seedling only needs to be pruned if it has two trunks that are starting to grow. Select the stronger trunk, and cut the weaker trunk at its base.

Approximately Two Year Old Seedling

The seedling is ready to be pruned when it begins to produce fan branches. This typically occurs around two years of age. Ideally the fan branches will form a "V" or funnel shape at the trunk. Select the three or four strongest branches and prune the rest within two days of the full moon.





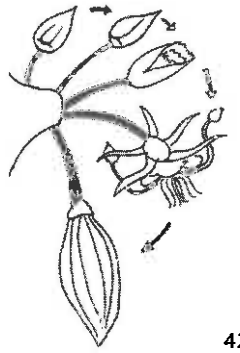
Before Full Maturity

A young healthy tree should not need any pruning, unless it is growing too tall (above 4 meters). If this occurs, trim the tips of the fan branches.

Approximately Five Year Old Tree

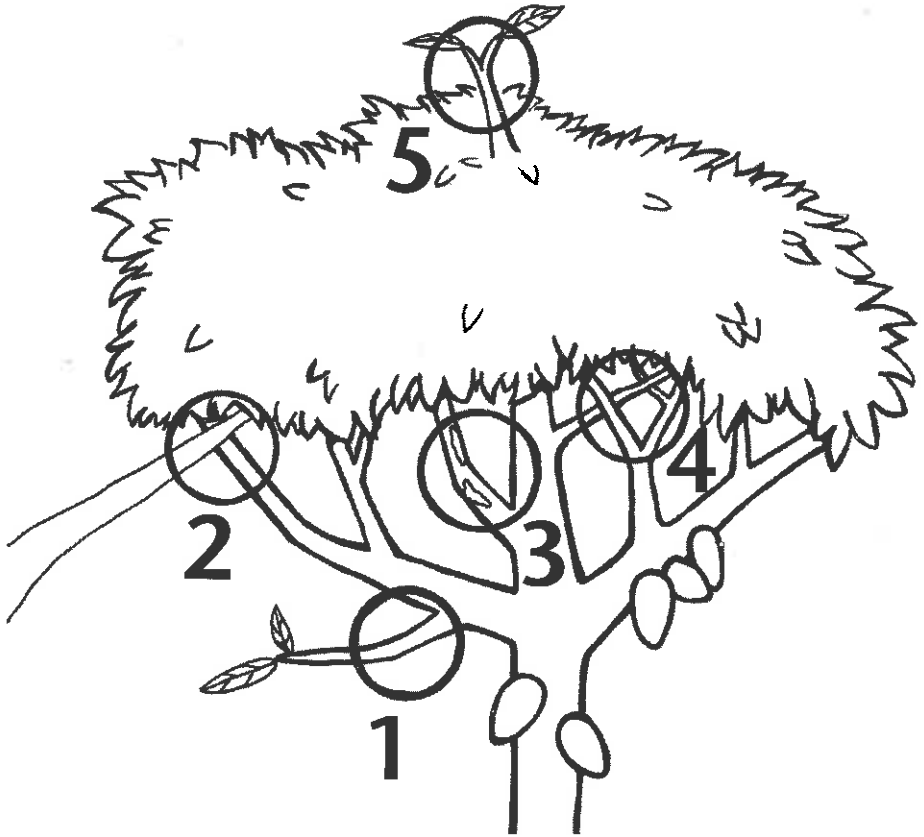
Once the tree begins producing flowers and pods, structural pruning must be done every year.

The structural pruning should be completed between two days before and two days after a full moon, once a year, after harvesting once the rainy season has begun.



Structural Pruning Process

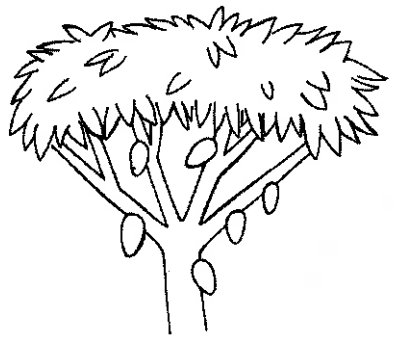
1. Remove low-hanging branches
2. Remove cross over branches
3. Remove diseased or dead branches
4. Remove tangled branches
5. Reduce the height of the tree, if needed (above 4 meters)



What does a well-pruned farm look like?

- There will be tunnels in between the rows of trees.
- Branches of one tree will touch the branches of the next tree, but not overlap.
- Clear paths to walk through for managing or harvesting your farm.

What does a well-pruned tree look like?



- The tree will have a flattened top to allow enough sunlight and air flow to reach the rest of the tree
- The branches will continue to grow at a "V" shape and make a funnel.

Chemical Fertilizers and Pesticides

Chemical fertilizers and pesticides are used to make crops grow more quickly and to keep them safe from insects. Unfortunately, the dangers of using chemical fertilizers and pesticides far outweigh the benefits.

The use of chemicals is linked to serious environmental and health issues.

Chemicals don't just stay on the plants they are used on, but seep into the soil and are spread for miles by the wind. These contaminants soak into the ground water and impact drinking water.

The chemicals have been linked to the severe decline in the honeybee population, the increase of cancerous tumors in wild animals, and the poisoning of fish.

Contaminants also have an impact on human health and are connected to cancer and other diseases in both adults and children.

TIP: Fertilizers can have a large effect on obtaining organic certifications. The Additional Information section has further content on certifications and organic fertilizers.

Organic ways to supplement your soil

Biochar

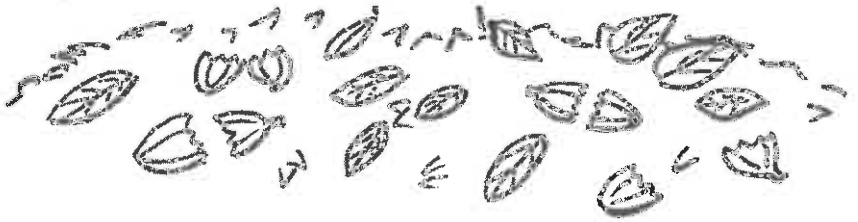
Biochar is a sustainable and nutritious fertilizer. This ancient practice converts agricultural waste into a soil enhancer that can hold carbon, boost food security, and increase soil biodiversity, and discourage deforestation. Contact Toledo Cacao Grower's Association (TCGA) to find out about availability of biochar for farmers in southern Belize.

Composting

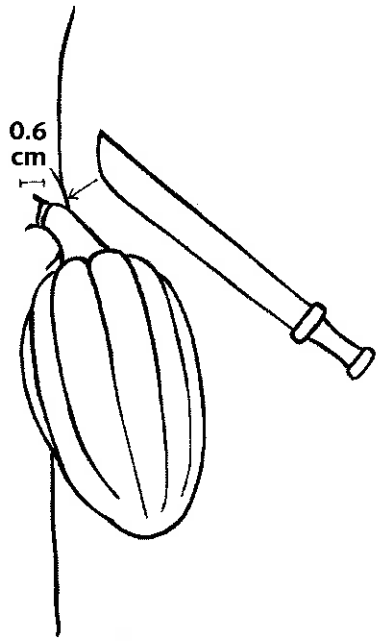
Compost is simply decomposed (rotted) organic material. The organic material can be plant material (used cacao pods, leaves, twigs, fruits, vegetables) or animal matter (animal excrement). The materials can be layered in bins or in piles on the ground to rot. Once decomposed it becomes an earth-like material and can be used to enrich the soil around your cacao and other trees and plants in your agroforest.

Mulching

Before rainy season begins, create mulch piles around the base of your cacao trees using leaf litter and sticks collected when you clean and thin your agroforest. Mulching can provide some nutrients for your soil, is good for keeping weeds away from the trees and ensures that nutrients are recycled within the system.



harvesting | *cacao pods*



Cut the pods off the tree with sharp shears that have been sanitized with alcohol. Cut the stem 0.6 centimeters from the tree.

Cacao trees start to produce pods three to five years after they have been planted. After reaching maturity, cacao trees produce flowers and pods year round. It takes five to six months from the appearance of flowers until there are ripe pods ready to be harvested. Once a pod matures, it takes about five to six weeks for the pod to completely ripen. Harvesting can begin in December and can last through May.

Cacao pods should be harvested when they are ripe. Typically most pods are ripe when they turn yellow or orange. A green pod will turn almost completely yellow; a burgundy (red) pod generally will ripen orange or yellowish orange.

Pods that are left on the tree after they have become ripe attract fungus and disease. Therefore, harvesting at regular intervals is recommended. Every ten to fourteen days is suggested.

harvesting | *cacao pods*

The Do's and Do-Nots of Harvesting

Do Not pull the pods off of the tree or climb the tree to reach the pods, especially with boots on, as this can rip the bark or damage the tree tissues.

Both of these actions will leave the tree susceptible to disease or you may damage the floral cushion, which will no longer produce flowers or pods.

Do Transport pods and beans in buckets or in clean bags used for cacao, sugar, flour, or rice.

Do Not use chemical bags or fertilizer bags because they can contaminate your beans.

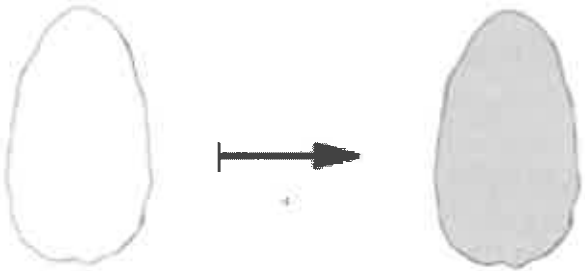
Do Harvested pods can sit in a cool dry place for up to five days.

This will allow you to harvest more pods in order to maximize the yield from your farm before you begin fermentation or sell the beans.

Do Remove the beans from the pod by hand.

Do Not rinse the seeds, since the pulp is required for fermentation.

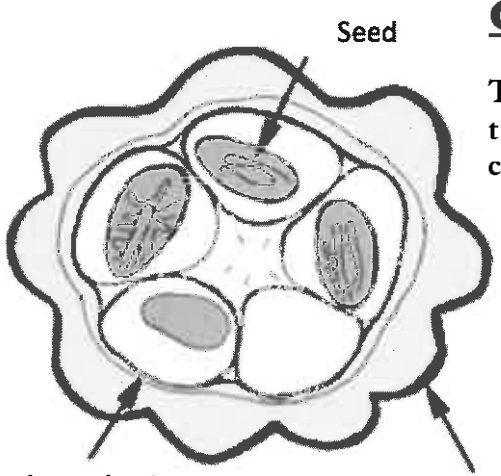
post harvest | *vocabulary*



Seed

Fermentation:

The process by which yeast causes the beans to turn from white or purple and covered in white pulp to brown, with a cocoa aroma and flavor.



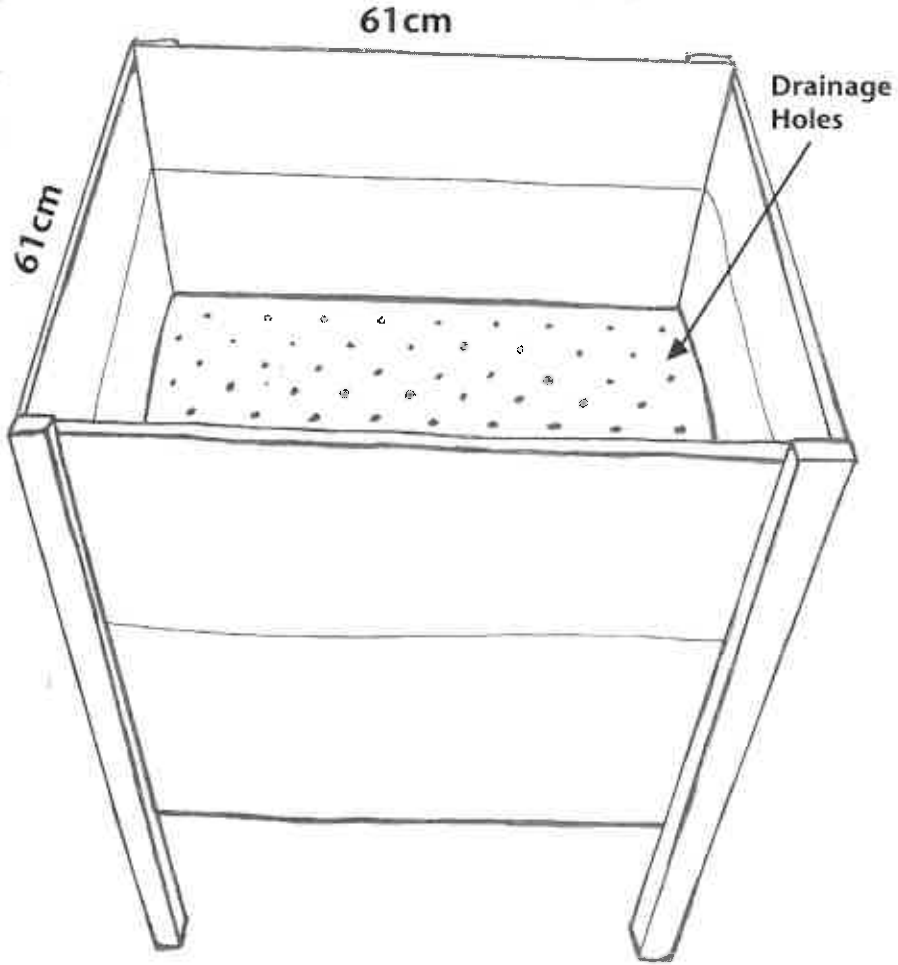
Cacao Placenta:

The inner connecting tissue that connects the cacao beans.

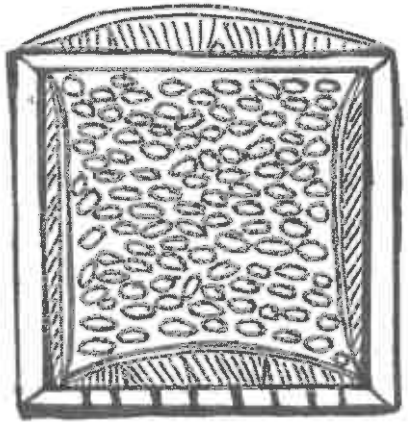
post harvest | *fermentation*

Build a wooden box that is about 61 cm x 61 cm. A box of this size holds approximately 8 buckets of wet beans. Make holes in the bottom of the box, so fermentation juices can drip out.

You need at least 23 kilograms (250 pods) of wet beans for proper fermentation. Unopened pods can be stored in a dry place for about five days until enough pods have been harvested.



Follow this six day schedule

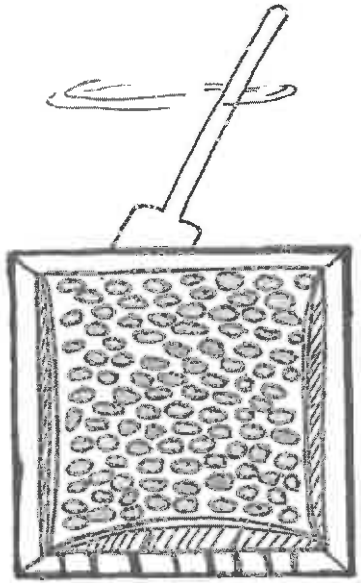


Day 1

Line the fermentation box with banana leaves. Fill the box with beans, and then cover them with banana leaves or a jute bag. This will help trap heat. Make sure there us some spaces at the bottom of the box for juices to drip out

Day 2

Let the beans begin to ferment.



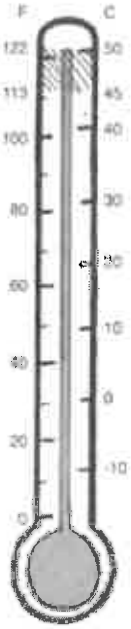
Day 3

Stir the beans to help them ferment uniformly. The temperature should start to be pretty warm at this stage, about 42 Celsius.

Make sure that the beans are fermenting at a temperature between 45 degrees Celsius and 50 degrees Celsius. These temperatures must be reached to ensure fermentation is happening.

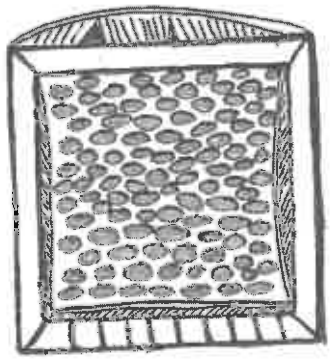
Day 4

Take the temperature of the beans. They should be at least 45 - 50 degrees Celsius.



Day 5

Stir the beans once again. Cut a couple of beans lengthwise to see if they color has changed from purple to chocolate brown and fissures have developed.

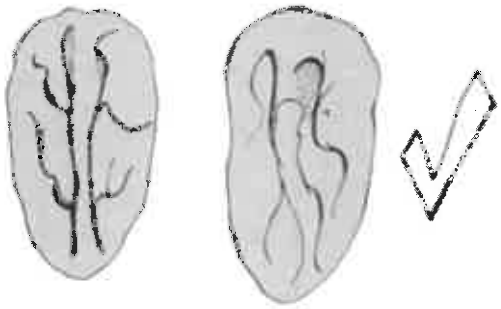


Day 6

Check the beans once again. If they are uniformly fermented and dark brown inside, remove them from the box. Allow the beans to dry.

post harvest | *fermentation*

Signs of Completed Fermentation



Inside of a cacao bean

Completely fermented beans will be:

- Light brown (not black) outside
- Chocolate brown (not black, purple, dark brown) inside
- Wrinkled inside

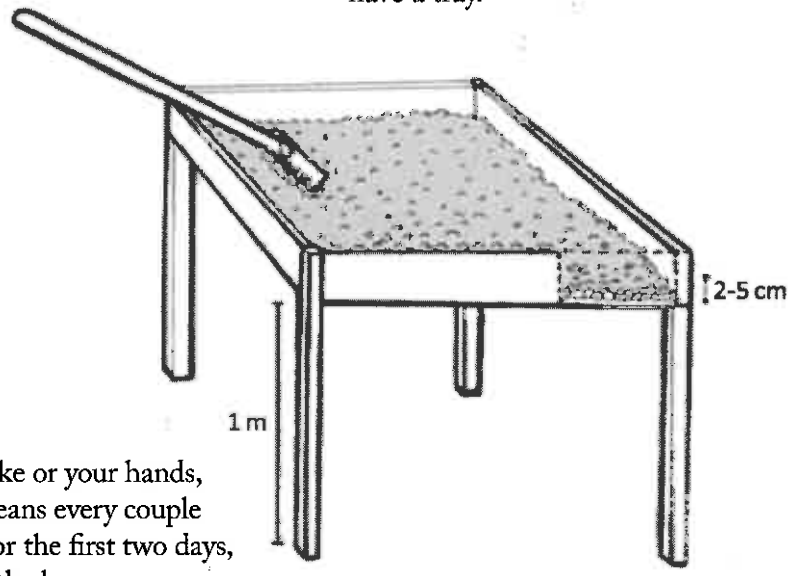
If the beans are not ready by day six, allow them to ferment for an extra day or until complete.

post harvest | *drying and storage*

Drying

A mesh tray should be built with legs 1 meter above the ground and should have a covering to protect the drying beans from rain.

Spread the beans out in a single layer on a tray built 1 meter above the ground. Beans can also be dried on a tarp on the ground if you don't have a tray.



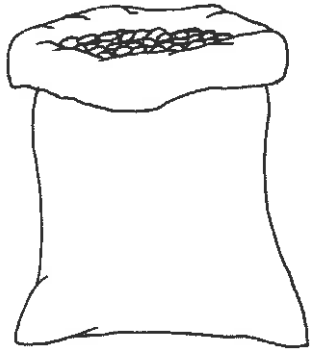
Using a rake or your hands, turn the beans every couple of hours for the first two days, then turn the beans every two hours to ensure they dry evenly and do not mold.

This should happen after about seven or eight days of full sun.

It should take approximately seven – ten days of full sun for the beans to dry completely.

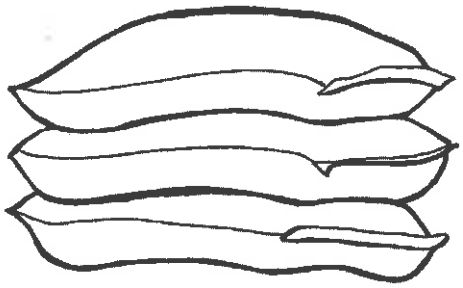
Properly dried beans will be reddish-brown on the exterior. Throw away beans that get moldy or show signs of insect contamination. Cut a few beans lengthwise to see if there are fissures and the color is light brown.

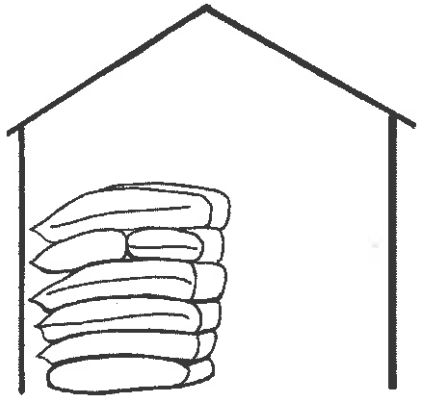
Cleaning & Storing Processed Beans



Before bagging the dried beans, remove dirt, straw, leaves or other materials.

Only store beans that have been properly dried. If the beans are still damp, they can grow mold inside the bags. Store dried cacao in clean, woven sacks. Do not use old fertilizer or chemical bags because they can contaminate your beans.





Keep the cacao in a clean, dry room. Leaving the sacks of cacao outside can attract pests and can cause them to mold and/or rot.

What pests and diseases can affect my cacao?

Mold and Rot

Causes: Too much moisture, too much shade and poor ventilation create a favorable environment for diseases.

Unpruned trees increase the amount of shade, which increases the moisture and humidity.

Tall weeds increase humidity and prevent air circulation.

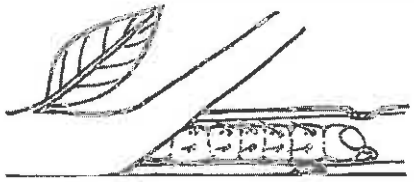
These conditions encourage fungal growth. If the diseased pods are not cut off the trees in time, the fungus can complete its life cycle and produce spores that quickly spread through the farm and infect other trees.

Prevention: The best way to prevent pests and diseases is to maintain a proper balance between shade and sunlight, regularly remove diseased pods, tall weeds and vines.

After the harvest is over and before the rainy season begins, gather all remaining pods that are leftover, remove from the farm to destroy them.

Diseased pods should be cut off as soon as identified. Remove them during midday when they are driest so the spores are less likely to detach and spread. Cover the pods with leaf litter or remove from the farm in a sealed bag.

Stem Borers

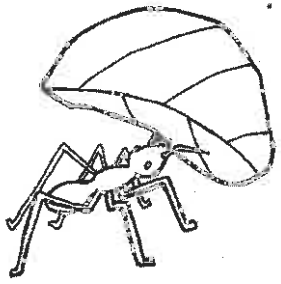


Stem borers are the larvae of moths and beetles that bore into the stems and trunks of the seedlings and trees. Stem borers can be particularly damaging to seedlings. They bore into a tiny hole in the stem, towards the base, to lay eggs and the larvae tunnel through the stem, weakening the tree and exposing it to infection and decay.

Prevention: Proper handling during initial planting can prevent damage to the branches and root system which will make seedlings less vulnerable to pests like stem borers.

Remove seedlings with stem borers from your nursery and destroy them. Do not transport or transplant seedlings with stem borers to your farm.

Leaf Cutter Ants



Leaf cutter ants are common pests, but they can be a serious problem especially for seedlings and new leaves.

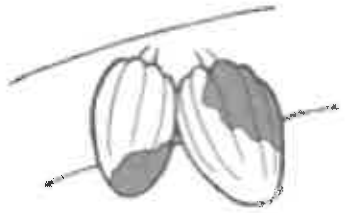
Prevention: Dig out the nest and kill the queen or regularly disturb the nest until the ants move away. Leaf Cutter Ants will return to the area, so removing them will require diligence.

Monilia

Monilia is a fungus that attacks the pods and is very destructive. Usually you can recognize the disease based on deformation of the pod, premature ripening spots, irregular brown spots, moldy spots in the brown spots and/or fruit that has mummified. The white moldy spots are spores that will detach from the pod, and be spread by wind, splashing rain- drops, humans or animals.

Prevention: Cut off diseased pods, before the mold has developed, with sanitized shears. Leave the pod where it falls and cover it with leaf litter or white lime. Copper fungicide may be used sparingly, once every two years.

Black Pod



Black pod is similar to Monilia in appearance, but the chocolate brown necrotic spots have a fishy (sea) smell.

Prevention: Good soil health and drainage. The disease attacks pods and several other parts of the tree, including shoots and flower cushions. The spores are spread by splashing rain, wind, ants and other animals or humans. Remove the pods before the white fungus appears using different shears than you use to prune and harvest, or sanitize the shears before you use them to prune or harvest again.

Phytopthora Diseases & Trunk Canker

Phytophthora and trunk canker are caused by the same organism that causes Black Pod.

Phytophthora causes dieback of chupons and nursery seedlings.	Trunk canker causes red lesions under the bark of mature trees and eventually causes the tree to die.

Prevention: Carefully eliminate dead seedlings from the nursery. When pruning, use sanitized equipment and treat cut surfaces with white lime paste. Regularly remove chupons to prevent them from becoming infected and spreading the organism to other parts of the tree. Cut off affected tissues and apply a wound dressing, such as a water and white lime paste.

Witches Broom

Witches' broom is a disease or deformity in a woody plant, typically a tree, where the natural structure of the plant is changed. A dense mass of shoots grows from a single point, with the resulting structure resembling a broom or bird's nest. This is caused by a fungus and affects all parts of the actively growing tree. Though Witches' Broom is not currently found in Belize it is one of cacao's most damaging diseases and could threaten Central America if diseased pods are transported into the country.

Why should I grow organic?

Choosing to grow organic can potentially open up new opportunities. There may be the possibility for international certifications, increased market value, and formation of a cacao cooperative. Organic methods can also help improve the surrounding environment, protecting your land for years to come.

What must my farm look like to be organic?

Standards for certifications vary by the certifying body or country. Some things to keep in mind are:

- The location of your farm to other non-organic farms
- Limited use of non-approved fertilizers and pesticides
- Organic compost, if used
- Some certifications require a certain number of years to have passed with no introduction of non-organic fertilizers or pesticides

Who do I contact to become certified?

We recommend getting in contact with the certifying bodies early on. In Belize, one of the best places to start is the Belize Organic Alliance (BOA). The BOA stays up to date on the standards for multiple international organic certifications. They have a website (www.boacertification.com), or can be contacted through the Belize Ministry of Agriculture.

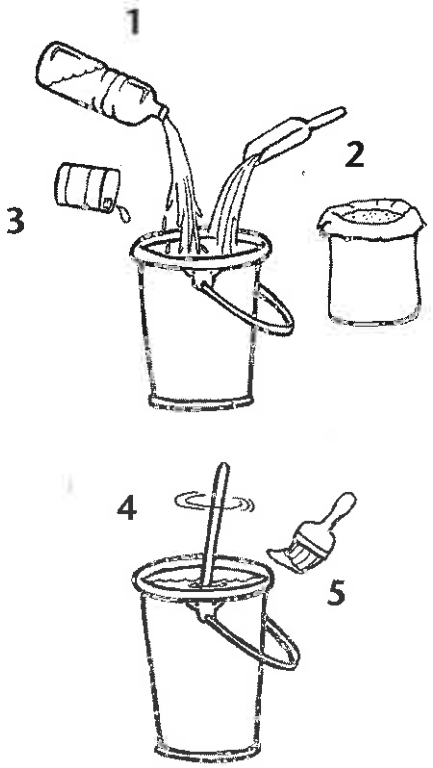
For general information about the United States Department of Agriculture (USDA) Organic Certification, please visit their website at: www.usda.gov

For general information about the European Union's (this includes the United Kingdom) organic certification, please visit the European Commission's website at: www.ec.europa.eu

Lime-based whitewash is a chemical-free method to help prevent pests and diseases. To make the whitewash, you will need a bucket, a large sanitized brush, a stirring rod, hydrated lime and oil (such as linseed or grower's). Many of these items can be bought at a local store that sells supplies for agriculture. You can still make the whitewash even if you cannot find the correct type of oil. The oil will only help the white wash stick to the bark a bit easier.

The wash will not keep for long and tends to dry out. Only make the wash as it is needed!

How to Make Lime Based-Whitewash



Step 1

Pour 500 mL of water into a bucket.

Step 2

Add approximately 225 grams of hydrated lime to the bucket.

Step 3

Add 5 mL of oil to the bucket.

Step 4

Mix together, and add more water if needed until the mixture looks like house paint.

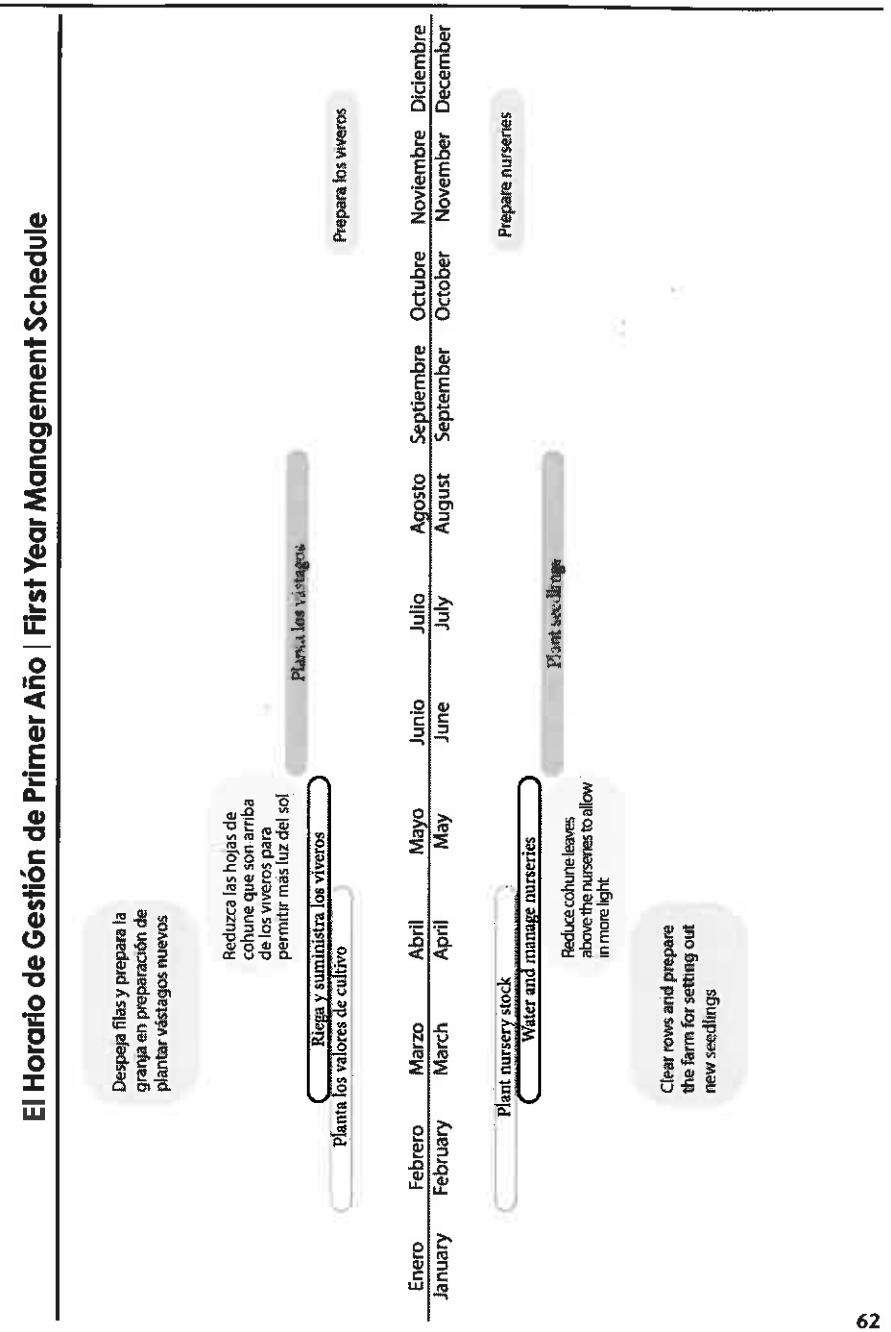
Step 5

You can now paint on the wash as needed!

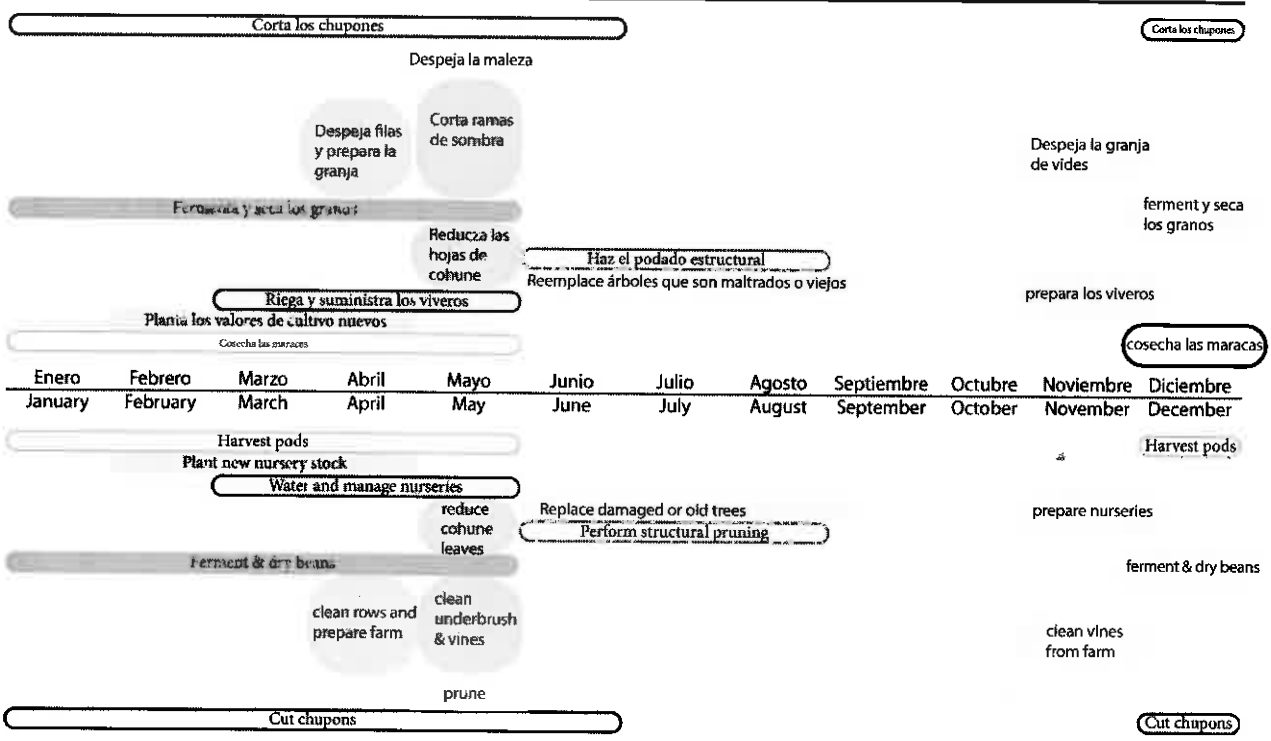
resources | *tools and supplies*

- ☐ *cacao seeds or seedlings*
- ☐ *companion species*
- ☐ *materials for germinating box*
- ☐ *source of water*
- ☐ *germinating soil*
- ☐ *materials for nursery*
- ☐ *planting bags*
- ☐ *machete*
- ☐ *sticks and rope or string*
- ☐ *closed top vehicle*
- ☐ *shovel*
- ☐ *knife or razor*
- ☐ *flagging tape or colored string*
- ☐ *pruning shears*
- ☐ *handsaw*
- ☐ *rubbing alcohol*
- ☐ *lime based whitewash*
- ☐ *small brush*
- ☐ *buckets for clean cacao*
- ☐ *sugar, flour, or rice bags*
- ☐ *fermentation box materials*
- ☐ *drill*
- ☐ *banana leaves*
- ☐ *wooden paddle*
- ☐ *thermometer for fermentation*
- ☐ *materials for mesh drying*
- ☐ *tray*
- ☐ *rake*
- ☐ *woven sacks*
- ☐ *white lime*

first year | *management schedule*



El Horario Anual de Gestión de la Granja de Cacao | Annual Cacao Farm Management Schedule



El Registro del Cultivo del Cacao

Temporada:			La Edad de la Granja:						
Área del Campo:			Variedad:						
Semanas	Fechas	Actividades	Horas de Trabajo				Gastos	El Rendimiento Mojado	Ventas
			No Pagado		Pagado				
			Adulto	Niño	Adulto	Niño			
1-2									
3-4									
5-6									
7-8									
9-10									
11-12									
13-14									
15-16									
17-18									
19-20									
21-22									
23-24									
25-26									
		Total:							

El Registro del Cultivo del Cacao

Temporada:			La Edad de la Granja:						
Área del Campo:			Variedad:						
Semanas	Fechas	Actividades	Horas de Trabajo				Gastos	El Rendimiento	Ventas
			No Pagado		Pagado				
			Adulto	Niño	Adult	Niño			
27-28									
29-30									
31-32									
33-34									
35-36									
37-38									
39-40									
41-42									
43-44									
45-46									
47-48									
49-50									
51-52									
		Total:							

Cacao Cultivation Record

Season:			Age of Farm:						
Field Area:			Variety:						
Weeks	Dates	Activities	Hours of Labor				Expenses	Wet Yield	Sales
			Unpaid		Paid				
			Adult	Child	Adult	Child			
1-2									
3-4									
5-6									
7-8									
9-10									
11-12									
13-14									
15-16									
17-18									
19-20									
21-22									
23-24									
25-26									
		Total:							

cultivation record | *27-52*

Cacao Cultivation Record

Season: Age of Farm:

Field Area: Variety:

Weeks	Dates	Activities	Hours of Labor						Expenses	Wet Yield	Sales
			Unpaid			Paid					
			Adult	Child		Adult		Child			
27-28											
29-30											
31-32											
33-34											
35-36											
37-38											
39-40											
41-42											
43-44											
45-46											
47-48											
49-50											
51-52											
		Total:									

resources | *further reading*

This section contains further reading. These readings are in English, and many are available online. Links for many are included.

"Belize Organic Alliance - Home." Belize Organic Alliance. N.p., (n.d.). www.boacertification.com/default.html

"Carbon Gold: Working with Cacao Farmers in Belize to Create a Rotating Biochar Production and Utilization System." International Biochar Initiative. www.biochar- international.org/carbongold

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Emch, M. (2003). The human ecology of Mayan cacao farming in Belize. Human Ecology, 31(1), 111-131.

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Harvey, C.A. and J.A. Gonzalez Villalobos. (2007). Agroforestry systems conserve species-rich modified assemblages of tropical birds and bats. Biodiversity and Conservation 16:2257– 2292.

How to Compost. www.howtocompost.org

Rainforest Alliance. Certification Verification www.rainforest- alliance.org/certification-verification

resources | *further reading*

Schroth, G., da Fonseca, G.A.B., Harvey, C.A., Gascon, C., Vasconcelos, H. L., & Izac, A. M. N. (Eds). (2004). Agroforestry and biodiversity conservation in tropical landscapes. Washington: Island Press.

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http://san.ag/web/

Teul, B., Cal, K., Nesbitt, C., & Ruscalleda, J. (2014). Integrated farming manual. http:// www.yaaxche.org/files/Agromanual2014.pdf

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http:// www.ams.usda.gov/AMSv1.0/NOPFAQsHowCertified,

Vos, J. G., Ritchie, B. J., & Flood, J. (2003). Discovery learning about cocoa: An inspirational guide for training facilitators.
http://worldcocoafoundation.org/wp-content/files_ mf/vos2003.pdf

Organizations in Belize that offer resources for Cacao Farmers

Belize Foundation for Research & Environmental Education (BFREE)
www.bfreebz.org

Maya Mountain Cacao Ltd
www.mayamountaincacao.com/

Toledo Cacao Growers Association
www.tcgabelize.com

Ya'axché Conservation Trust
www.yaaxche.org

BFREE

BELIZE FOUNDATION FOR RESEARCH & ENVIRONMENTAL EDUCATION
http://www.bfreebz.org/

Belize

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The rainforest is our classroom!