

The Shade Canopy of Cocoa

Eduardo Somarriba Chavez · Francisco Quesada Chaverri
Luis Orozco Aguilar · Rolando Cerda Bustillos · Marilyn Villalobos Rodriguez
Shirley Orozco Estrada · Carlos Astorga Domian · Olivier Deheuveld
Eduardo Say Chavez · Romina Villegas Caceres

COLLECTION

PCC

FIELD
SCHOOLS

5

The Central American Cacao Project (PCC) at CATIE (Tropical Agricultural Research and Higher Education Center) aims to increase the productivity, diversity and financial and environmental value of the cacao plantations of at least 6,000 Central American families.

Working closely with cacao farming families, the Project creates alliances with other partners in the region in order to enhance the social interactions, competitiveness and business capacity of the producers' organizations and improve the living conditions of their members.

The Project promotes efforts to increase the knowledge and skills of farming families and students at agricultural schools, technical colleges and agronomy faculties, for the sustainable production of cacao.

The Project also offers equal opportunities as well as economic, social and cultural responsibilities for men and women of all ages and from different ethnic groups in all its spheres of action.

For more information contact:

Shirley Orozco Estrada
PCC Communications
CATIE, Costa Rica
Tel: (506) 2558-2466
E-mail: sorozco@catie.ac.cr

ISBN: 978-9977-57-543-8



9 789977 575438



Technical series
Extension materials No. 5



The Shade Canopy of Cocoa

Eduardo Somarriba Chavez · Francisco Quesada Chaverri
Luis Orozco Aguilar · Rolando Cerda Bustillos · Marilyn Villalobos Rodriguez
Shirley Orozco Estrada · Carlos Astorga Domian · Olivier Deheuvels
Eduardo Say Chavez · Romina Villegas Caceres

Tropical Agricultural Research and Higher Education Center (CATIE)
Turrialba, Costa Rica
2011

The Tropical Agricultural Research and Higher Education Center (CATIE) is a regional center dedicated to research and graduate education in agriculture, and the management, conservation and sustainable use of natural resources. Its members include the Inter-American Institute for Cooperation on Agriculture (IICA), Belize, Bolivia, Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Venezuela, Spain and the State of Acre in Brazil.

633.7434

S693 Somarriba Chavez, Eduardo

The shade canopy of cocoa / Eduardo Somarriba Chavez...[et al.] . – 1° ed. – Turrialba, C.R : CATIE, 2011.

45 p. : il. – (Technical series. Extension materials / CATIE ; no. 8)

ISBN 978-9977-57-543-8

Tambien como: Collection field schools : no.5

1. Theobroma cacao – Sombra – Materiales de extension 2. Theobroma cacao – Produccion vegetal – Materiales de extension I. Somarriba Chavez, Eduardo II. Quesada Chaverri, Francisco III. Orozco Aguilar, Luis IV. Cerda Bustillos, Rolando V. Villalobos Rodriguez, Marilyn VI. Orozco Estrada, Shirley VII. Astorga Domian, Carlos VIII. Deheulves, Olivier IX. Say Chavez, Eduardo X. Villegas Caceres, Romina XI. CATIE XII. Titulo XIII. Serie.

Credits:

Authors:

Eduardo Somarriba Chavez
Francisco Quesada Chaverri
Luis Orozco Aguilar
Rolando Cerda Bustillos
Marilyn Villalobos Rodriguez

Shirley Orozco Estrada
Carlos Astorga Domian
Olivier Deheulves
Eduardo Say Chavez
Romina Villegas Caceres

Editing:

Shirley Orozco Estrada
Marilyn Villalobos Rodriguez

Technical Review:


Phillippe Lachenaud
Jesus Sanchez Lopez
Aroldo Dubon Dubon

**Illustration,
design and arts:**

Alexander Corrales Mora

Coordination:

Shirley Orozco Estrada

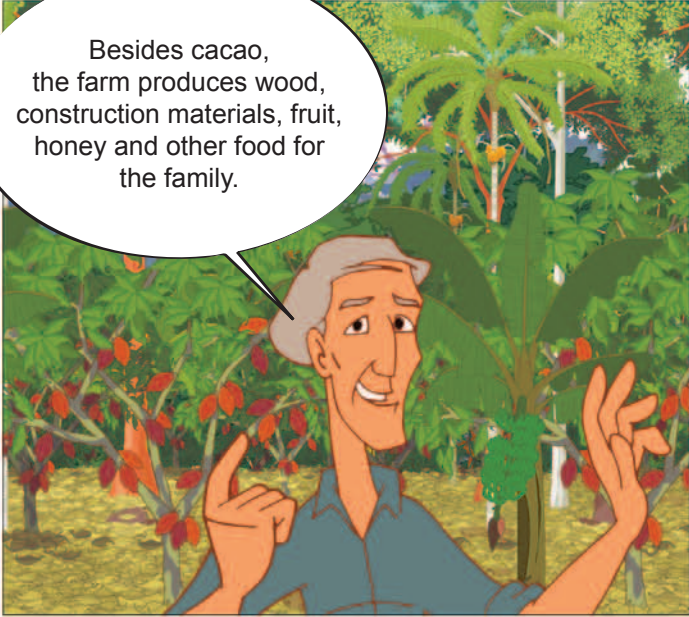


Hi, welcome to our farm. Let's begin the meeting.


Make yourselves comfortable over here in a circle. There are enough benches and stumps so that we can all sit down.

I want to thank Gerardo and Miriam for inviting us to their farm. Today we are going to talk about how to improve shade on our cacao farms.

Yes, we will talk about "agroforestry," which is simply managing trees and other plants with cacao in the same piece of land.




Besides cacao, the farm produces wood, construction materials, fruit, honey and other food for the family.



Hey, I am part of the family...


this is beginning to sound interesting...fruit, food...

I like agroforestry!




A cacao farm, also called a cacao plot, is a piece of land where cacao is grown, with or without other trees, palms, bananas and other species of plants.

When cacao is grown in conjunction with trees and other tall plants that provide shade, all of these trees and plants together are called the shade canopy of the cacao farm, or simply, the canopy.




You have come to the right place. Here we have cacao plots with different types of shade that we can study and compare.

Shade trees on the cacao farm



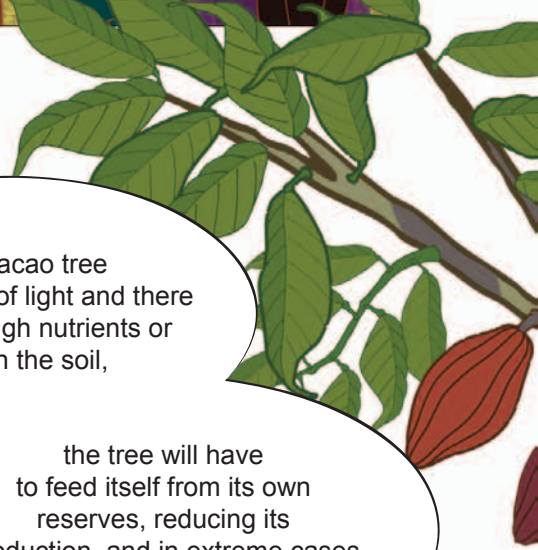
Friends, did you know cacao originally lived in the forest along the banks of the rivers that formed the Amazon Basin?

That's right, and we know that cacao can grow outside the forest and in various climates. There are farmers who cultivate cacao under shade and others that grow it in full sun.



The shade canopy captures part of the light that falls on the cacao plot. We use the canopy to balance the quantity of light

the cacao receives with the fertility of the soil.



If the cacao tree receives a lot of light and there are not enough nutrients or water in the soil,

the tree will have to feed itself from its own reserves, reducing its production, and in extreme cases it could lead to disease or even death.



Of course, it would be like forcing me, a high-level Olympic-type athlete, to run 15 kilometers a day without giving me anything to eat.

What a modest monkey!

My body would not be able to take it and I would die. Imagine the loss to the world!

Absolutely. But at a high price. Thank goodness there are other solutions for those who could not cover those high costs.

But a farmer could fertilize and water the soil in order to cultivate cacao with little shade or even in full sun.

Isn't that true?



Yes, Alberto. The alternative is to use shade trees that also produce valuable goods and services for the family.





Goods?

Services?

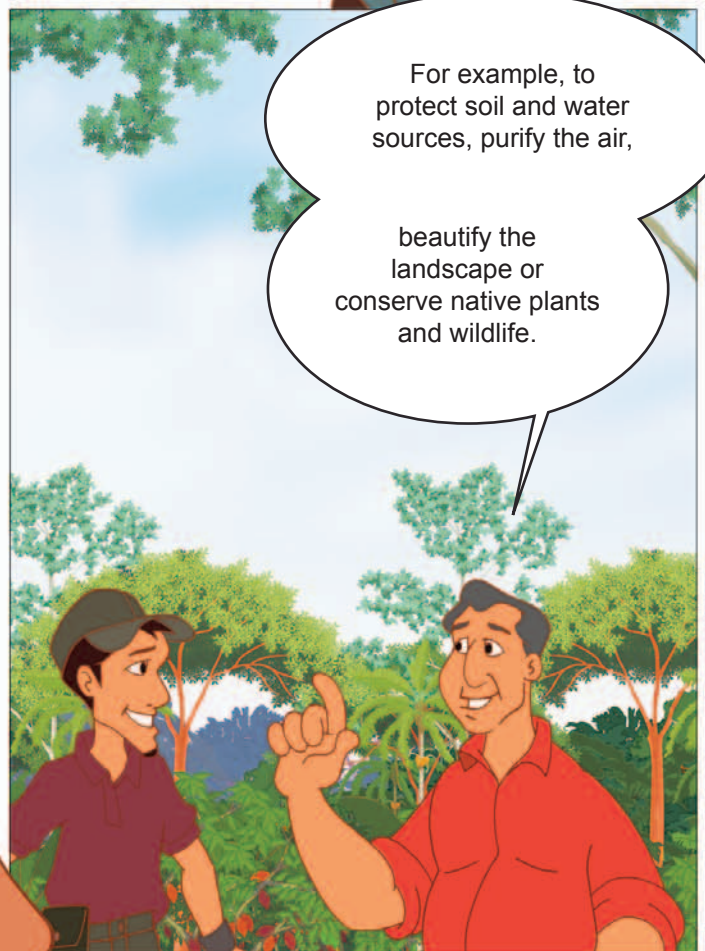
Yes, Maria, goods and services. Goods are things that the cacao farm provides that we can touch with our hands.



For example, lumber, firewood, seeds, medicine, thatch for roofs and fruit to sell, for family consumption or to feed domestic or wild animals.




Services are things that benefit the farm, the environment and people but that we cannot touch.




For example, to protect soil and water sources, purify the air,

beautify the landscape or conserve native plants and wildlife.

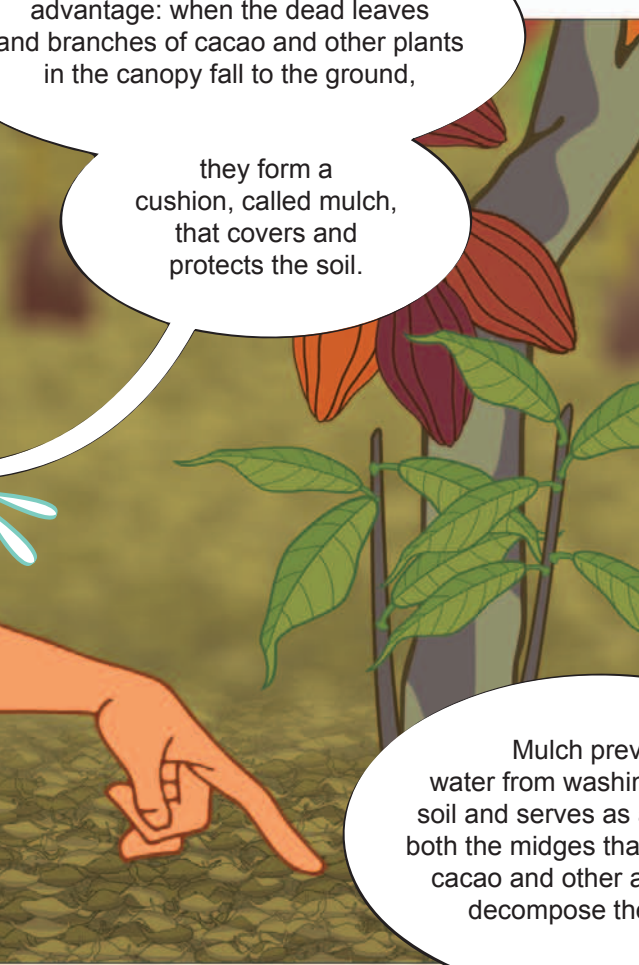


Does someone want to explain how the canopy protects the cacao?




I do! The trees of the canopy keep raindrops from hitting the cacao flowers directly and protect them from strong winds.

And they prevent the sun from burning the young cacao leaves.



There is another advantage: when the dead leaves and branches of cacao and other plants in the canopy fall to the ground,

they form a cushion, called mulch, that covers and protects the soil.



That's right, because when the mulch decomposes, it releases nutrients that fertilize the soil and benefit the cacao and the plants in the shade canopy.

Mulch prevents water from washing away the soil and serves as a nursery for both the midges that pollinate the cacao and other animals that decompose the mulch.



I can add another advantage: The shade trees protect wild animals.

I camp out under the cacao trees when there is a storm and heavy rain.

I am terribly afraid of lightning and thunder.



All that we have mentioned are services. And now, what goods do we obtain from the trees and plants on the cacao farm?

Oh, a lot of things,

just like the poster explains:

Trees also provide this important service to me.



- Lumber to build houses, boats, furniture.
- Fence posts
- Firewood.
- Palm leaves and stalks for roofs, floors and walls of the houses.
- Vines to tie things with.
- Fruits for the family to sell and to feed to domestic and wild animals.
- Industrial products, such as palm oil, rubber coconut and others.
- Medicinal plants.
- And many others.





The goods that we get from the cacao farm help us when the price of cocoa goes down.

I can testify to that. If it were not for the cacao farm, I would have had to buy medicines at the pharmacy.

Look, I treated the mange on my back by rubbing it with leaves of a medicinal tree that I found on the cacao farm,

and look, it is almost gone.




Oops, I almost asked him where he bought that red-striped shirt he is wearing. Luckily I didn't open my mouth.



Shaded cacao farms produce lumber, fruit and other goods, conserve wild plants and animals, protect water sources and beautify the landscape. Long live shaded cacao farms!

Six types of cacao farms




I suggest that we talk about the different types of cacao farms found around the world.

That's a good idea, Carmen. If we look closely, we see that cacao is grown with different plants on different farms.

That is true here and elsewhere in the world.

Then let's ask ourselves.

how we choose the canopy plants for our farms?



You're right, Miriam. For example, if the family only wants to produce cacao,

the canopy will certainly have trees that primarily provide shade.

In my opinion, we put plants in the canopy that meet the family's needs.



On the other hand, if the objective is not to depend solely on cacao, we will see trees on the farm that provide lumber,

fruit and things that the family can use or sell.

Don't you think that the family's likes and dislikes also come into play when deciding which plants to combine with the cacao?



Of course. If, for example, the family knows a lot about the production and marketing of plantains or oranges,

we will likely find those fruits on the cacao farm.

And if there is fear of lightning, then it is almost certain that no tall trees will be found on that farm.

But, if they like flowers, they will allow trees with showy flowers to grow or they will plant them.

Not long ago Miriam and I went to a cacao fair and we learned that there are six types of cacao farms. Last night we wrote them down on this poster to show you.



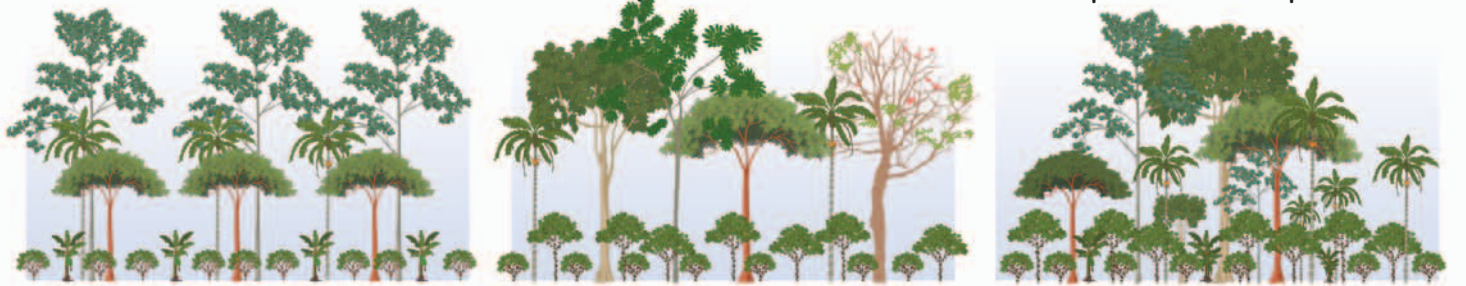
The six most-common types of cacao farms in the world



1. Cacao without shade

2. Cacao with one species used only for shade

3. Cacao associated with other perennial crops



4. Cacao with mixed shade

5. Rustic cacao

6. Agroforests



Let us look at each type in detail. Alberto, would you tell us about the first type?

My pleasure. Cacao without shade is grown on commercial farms where, for example, grafts are planted close together.

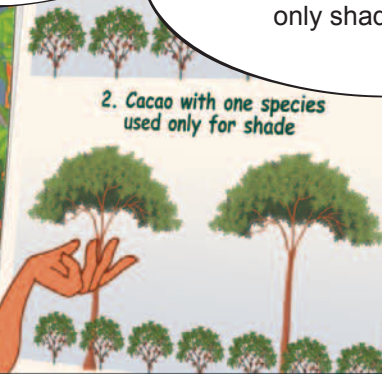
I have seen farms like that. The management is intensive and very technical. They apply a lot of fertilizer and irrigate when the soil is dry.

It is a very expensive operation, but the yields are high.



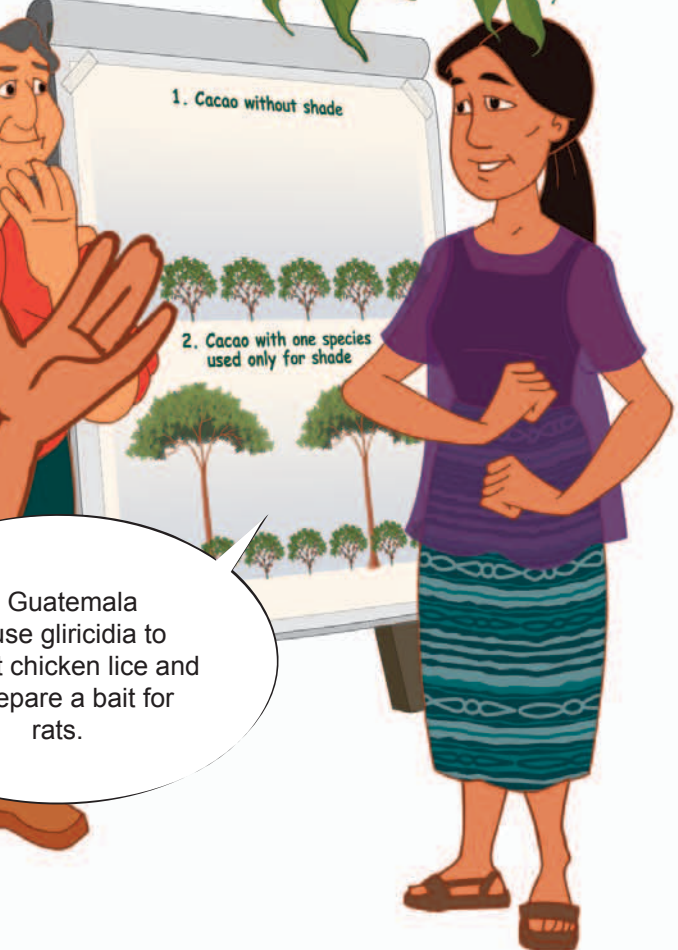
My uncle has a cacao farm of the second type, with only a shade species—poro.


Some of my neighbors use monkey tail or gliricidia instead of poro as the only shade species.




Besides shading the cacao, poro, monkey tail and gliricidia improve soil fertility.

In Guatemala we use gliricidia to combat chicken lice and to prepare a bait for rats.



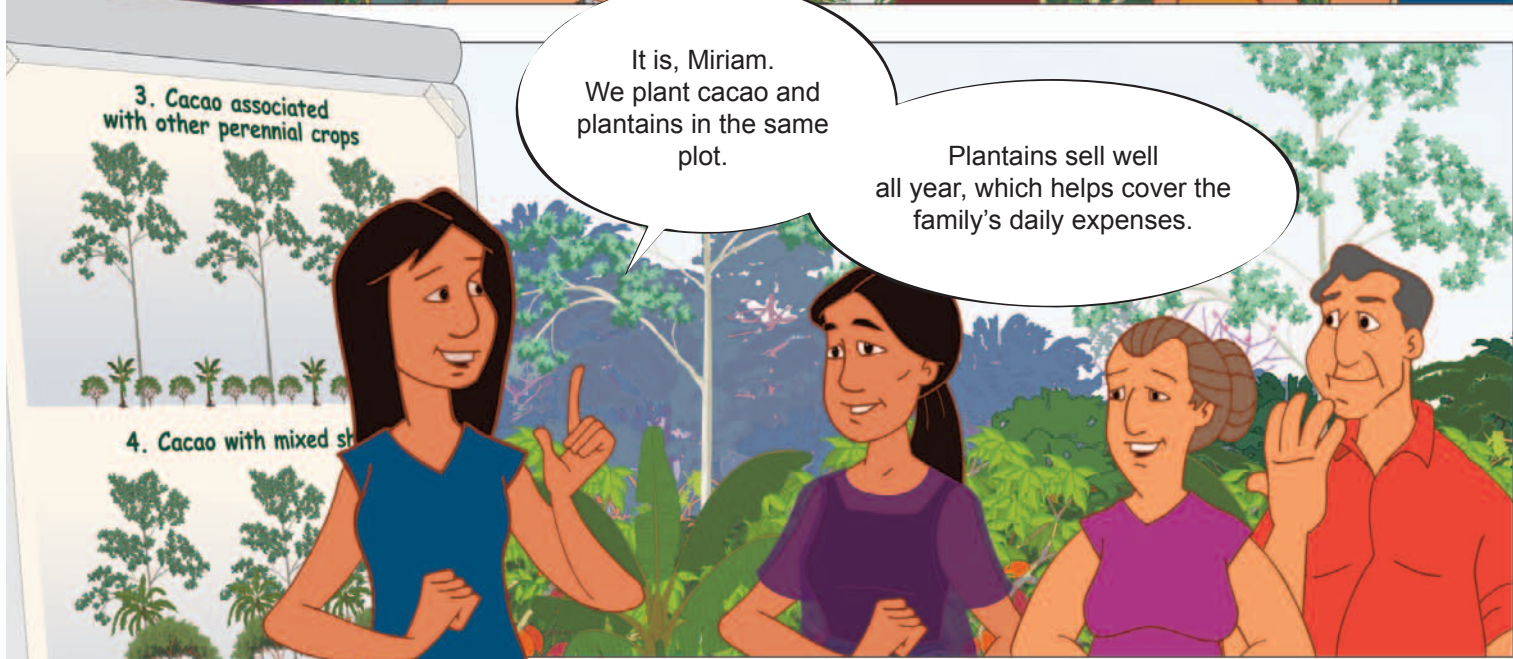


Hey...I'd better run right now to warn my rat friends about this, so they avoid that bait when they come to eat cacao.



On the third type of cacao farm, cacao is planted with other commercially valuable crops.

If I am not mistaken, Carmen's cacao farm is this third type, isn't it?



It is, Miriam. We plant cacao and plantains in the same plot.

Plantains sell well all year, which helps cover the family's daily expenses.

My uncle Eliseo's cacao farm is the fourth type: cacao with mixed shade.

On this cacao farm there are several species of trees and plants for shade, timber and fruit.

These are the cacao farms that I like best, with bananas and other fruit to eat and good shade to rest under.

4. Cacao with mixed shade

Of the four types of cacao farms that we have seen here,


the trees and plants in the shade canopy have been planted or selected from among those that came up naturally on the farm.

3. Cacao associated with other perennial crops

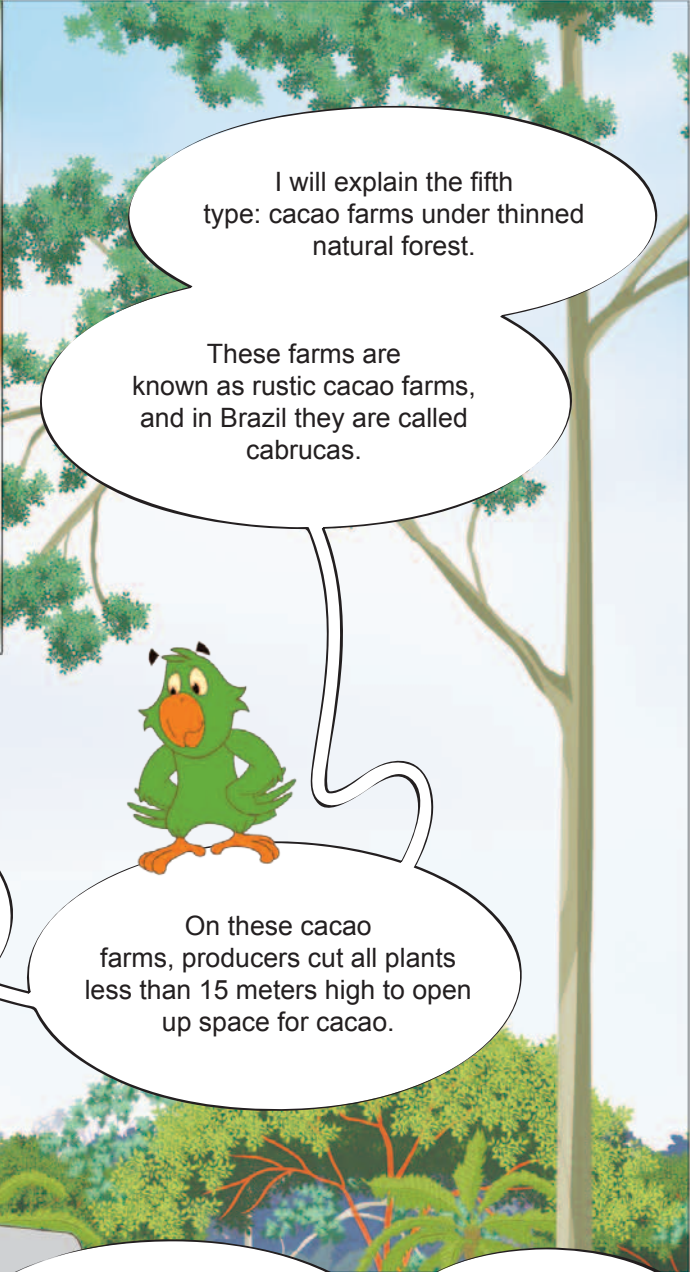
4. Cacao with mixed shade

True, Cecilia. Generally on these cacao farms there are few native forest species, and although the farm can look like a forest,

it is not a natural forest but a very artificial one.



On the two next types of cacao farms, the shade canopy depends on natural forest.



I will explain the fifth type: cacao farms under thinned natural forest.

These farms are known as rustic cacao farms, and in Brazil they are called cabruças.

Then three-fourths of the tall trees are cut to open the canopy and let light get to the cacao.

On these cacao farms, producers cut all plants less than 15 meters high to open up space for cacao.



5. Rustic cacao

Rustic cacao farms have many native forest trees but many are not capable of reproducing under the rustic cacao

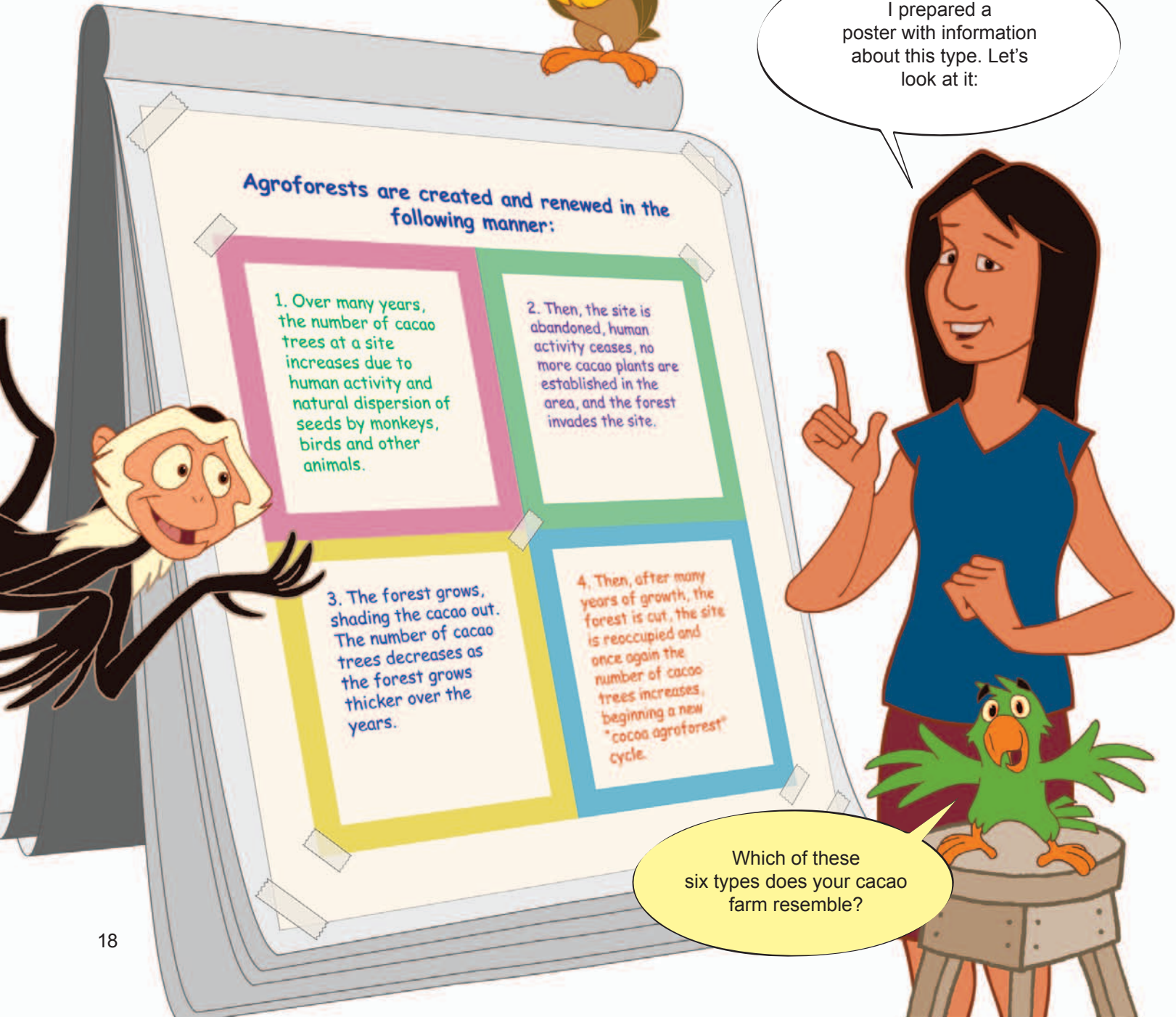
and in time will disappear from the farm.



Finally, we have the sixth type of cacao farm:

the cacao agroforests.

I prepared a poster with information about this type. Let's look at it:



Agroforests are created and renewed in the following manner:

1. Over many years, the number of cacao trees at a site increases due to human activity and natural dispersion of seeds by monkeys, birds and other animals.

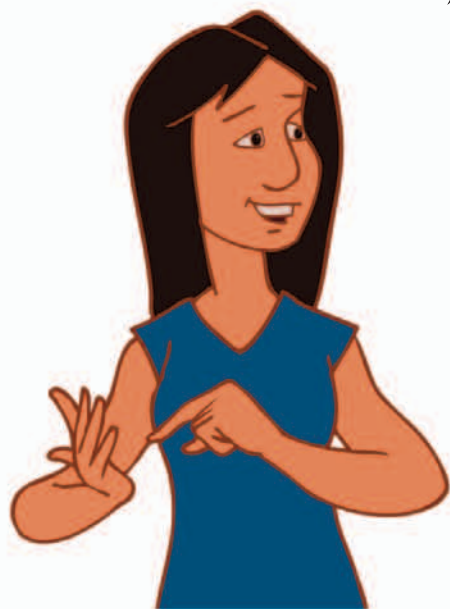
2. Then, the site is abandoned, human activity ceases, no more cacao plants are established in the area, and the forest invades the site.

3. The forest grows, shading the cacao out. The number of cacao trees decreases as the forest grows thicker over the years.

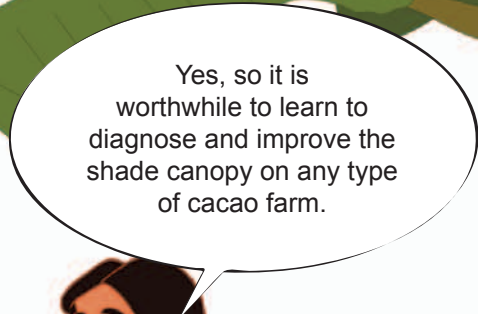
4. Then, after many years of growth, the forest is cut, the site is reoccupied and once again the number of cacao trees increases, beginning a new "cacao agroforest" cycle.

Which of these six types does your cacao farm resemble?

Analysis of the shade



We have already seen how important the shade canopy is for cacao and for the family.



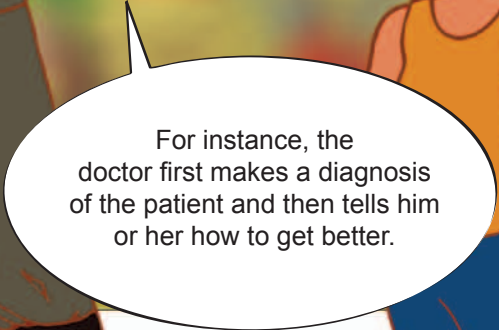
Yes, so it is worthwhile to learn to diagnose and improve the shade canopy on any type of cacao farm.



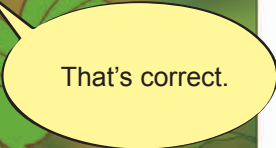
Diagnose?



To diagnose is to evaluate whether a thing is good or not.



For instance, the doctor first makes a diagnosis of the patient and then tells him or her how to get better.



That's correct.

The method for diagnosing the canopy has five steps. Let's look at them:



Nothing more and nothing less. These are the five steps for diagnosis. Now let's look at each step in more detail.

First step

First step:
Describe what your family wishes to get from the cacao farm and how much you are willing to invest in managing it.

For example, a family can say, "We want to give priority to cacao cultivation and we are going to renew some trees with new grafts to double production."

Our family has already decided that we want to keep producing cacao, plantains and timber.

Another family could say, "Each year we are going to harvest the cocoa on only this half of the cacao farm and we are going to leave the other half for the monkeys"

—such happy and charming creatures—so that they can eat it and invite their family and friends."

Thank goodness nobody listens to that crazy monkey! Pay attention and quit interrupting, so we can go on to the second diagnostic step.


Second step

Second step:
Evaluate seven site characteristics that affect shade on the cacao farm. Let's look at them on this poster.

Site character

1. Wind If there are strong winds, it is necessary to plant windbreaks to protect the cacao. The windbreaks are planted in rows and facing the direction the wind comes from. These windbreaks provide the cacao with lateral shade.

3. Soil fertility If a cacao 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.



Site characteristics that affect shade on the cacao farm

1. Wind If there are strong winds, it is necessary to plant windbreaks to protect the cacao. The windbreaks are planted in rows and facing the direction the wind comes from. These barriers provide the cacao with lateral shade.

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

3. Soil fertility If a cacao 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.

4. Availability of water In humid zones or with irrigation, the plants in the shade canopy do not affect the cacao negatively. In areas that have six or more continuous dry months, it is not a good idea to plant cacao, 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 cacao.





5. Slope of the land If the cacao farm is planted on a hillside, sloping land, it may receive sun light only at certain hours of the day, depending on the degree of the slope and its orientation.

6. Tall plants on the boundaries of the cacao farm Trees and other tall plants on the boundaries of the cacao farm can block the sun and provide 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.

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

Listen: to understand the movement of the sun, we should learn to use a compass, a very simple device that shows where north is.

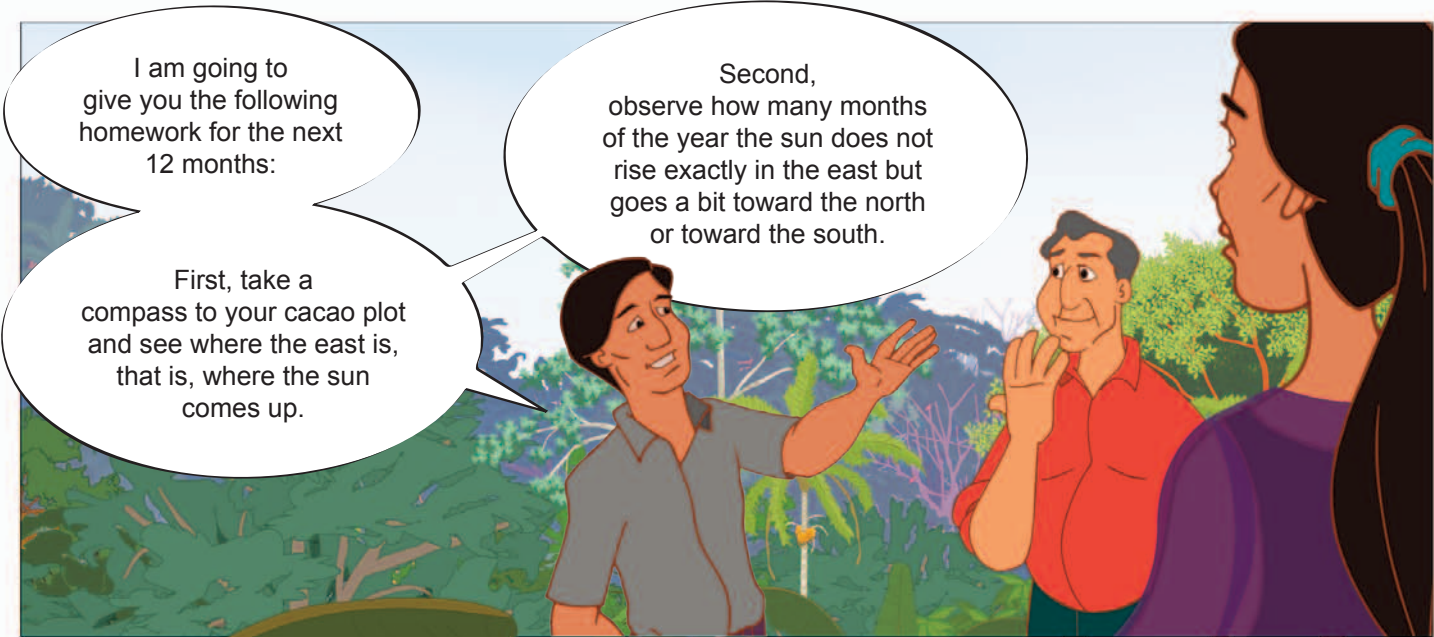
Let's see how it works.

I'll explain. We all know that the earth is a great ball that functions like a magnet, that makes the needle of the compass always point north.

We also know that if we face north, that is, where the needle points,

and we lift and extend both arms to the sides, the right arm points to the east, the left points west and our back is toward the south.

In the morning the sun comes up each day more or less to the east, and in the afternoon it goes down more or less in the west.



You would need more plants in the shade canopy of a cacao plot directly illuminated for eight months of the year than one illuminated directly only four.

Now I get the point.

In high school I learned that one of the sages who contributed most to understanding the movement of the sun and stars in the sky was the Italian Galileo Galilei.

Galileo Galilei?
That sounds weird.

We were taught in school that the real name of the sage was Hen-ileo Hen-ilei.

Third step

Third step:
Evaluate the self-shading and the phenology of the cacao plants.

Self-shading,
“phenol” what?

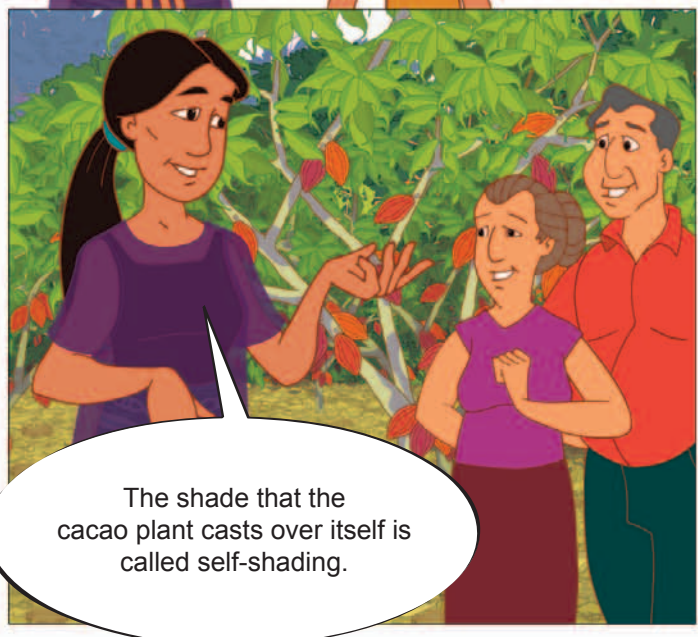


I have really impressed you, right? Because I am super intelligent, I use only technical words.

Presumptuous monkey, there's no need to be so impressed with yourself.

We owls learned those words in the first grade.


OK, no fighting. First we are going to see self-shading and then we will see phenology. Cecilia, please take over.



The shade that the cacao plant casts over itself is called self-shading.




The shade that neighboring cacao trees cast onto each other is also self-shading.



Self-shading depends on the age and size of the cacao plant. A young plant has less self-shading than an adult plant.


Yes, because when a cacao plant is young, the crown is small,

with few leaves and a lot of open space between the leaves. If we expose this plant to the sun, the light completely illuminates all its leaves.




Yes, but later, as the plant grows and the crown develops,

the leaves above begin to cover and shade the leaves below and increase self-shading.




Correct. So we plant bananas, plantains, cassava and other fast growing species to compensate for little self-shading by the young cacao.

This means that more shade from the canopy is needed for young cacao than for adult cacao.




The amount of self-shading also depends on whether the cacao trees come from seed or grafts.

You're right. Trees from seed are larger and have more self-shading than grafted cacao trees.




Self-shading is greater on a cacao farm that is pruned infrequently than on one that is regularly pruned.

Self-shading is greater when the cacao trees are planted close together than when they are widely separated.

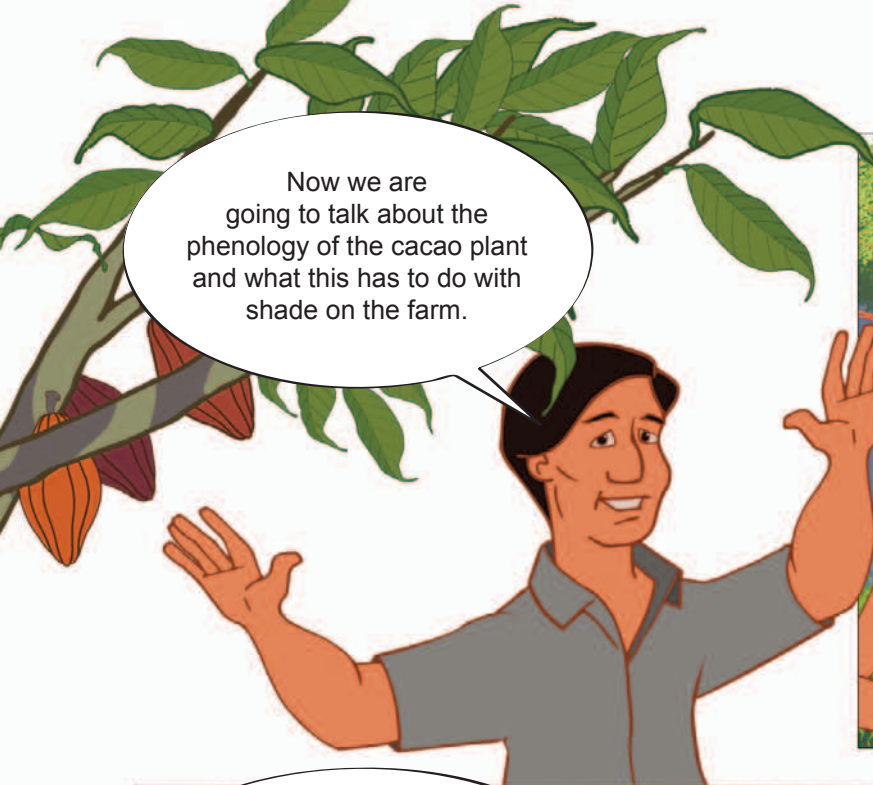


The greater the self-shading within the cacao farm, the fewer useful plants can we use in the shade canopy.

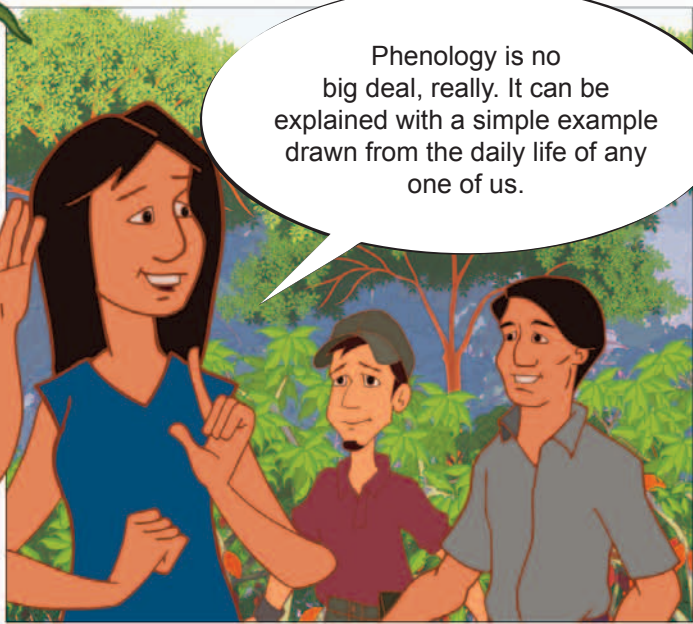
Yes, pruning regulates the shape and size of the crowns, according to the spacing between the cacao trees.



That's "oobvious"!



Now we are going to talk about the phenology of the cacao plant and what this has to do with shade on the farm.



Phenology is no big deal, really. It can be explained with a simple example drawn from the daily life of any one of us.



We all know that everybody does different things during a year—in some months some things and in other months other things.

I get it. For example, here we prepare the land to plant our food crops between March and April, we plant in May with the arrival of the rains,

we cultivate until November and we let the land rest between December and February.



Then we begin another annual cycle in March, and so it is year after year.



Forever and ever...

Cacao plants carry out five activities every year:

1. Flush new leaves

2. Flower

3. Produce fruit

4. Ripen fruit

5. Rest

Resting. Ah, that is without doubt the most important stage of all,

don't you think?


And what does cacao phenology have to do with shade on the cacao farm?

It has lots to do with it because the cacao plant needs more light when it is flowering and producing fruit.

So, when you enter the cacao farm, look at what phenological state it is in and then check whether it is in line with the amount of shade from both self-shading and canopy.


Fourth step

Evaluate the canopy and the shade trees.




The first thing we must do is go through the cacao farm to see whether the shade is distributed evenly on all of the plot

or whether there are “patches” with a lot of shade and “holes” without shade or with too little shade.



The ideal is for shade to be evenly distributed throughout the farm, with all cacao plants having the same shade conditions to grow and produce.

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. That is what I do.



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 cacao.

Patches with a lot of shade produce too much humidity, which favors diseases that are very harmful to the cacao,

such as monilia, witches’ broom and black pod.



Fifth step

List the plant species that we have in the canopy and describe seven characteristics of each one.

For each species we record

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.
7. Months of the year when the crown has no leaves.

Let's look at how these characteristics affect shade on the cacao plot. Who wants to begin?

I will start. If we use trees with wide crowns, we can only plant a few trees on each hectare of cacao.



We farmers know that tall tree crowns provide sparse shade and low tree crowns provide heavy shade.

The height of the trees affects the shade they cast. How?

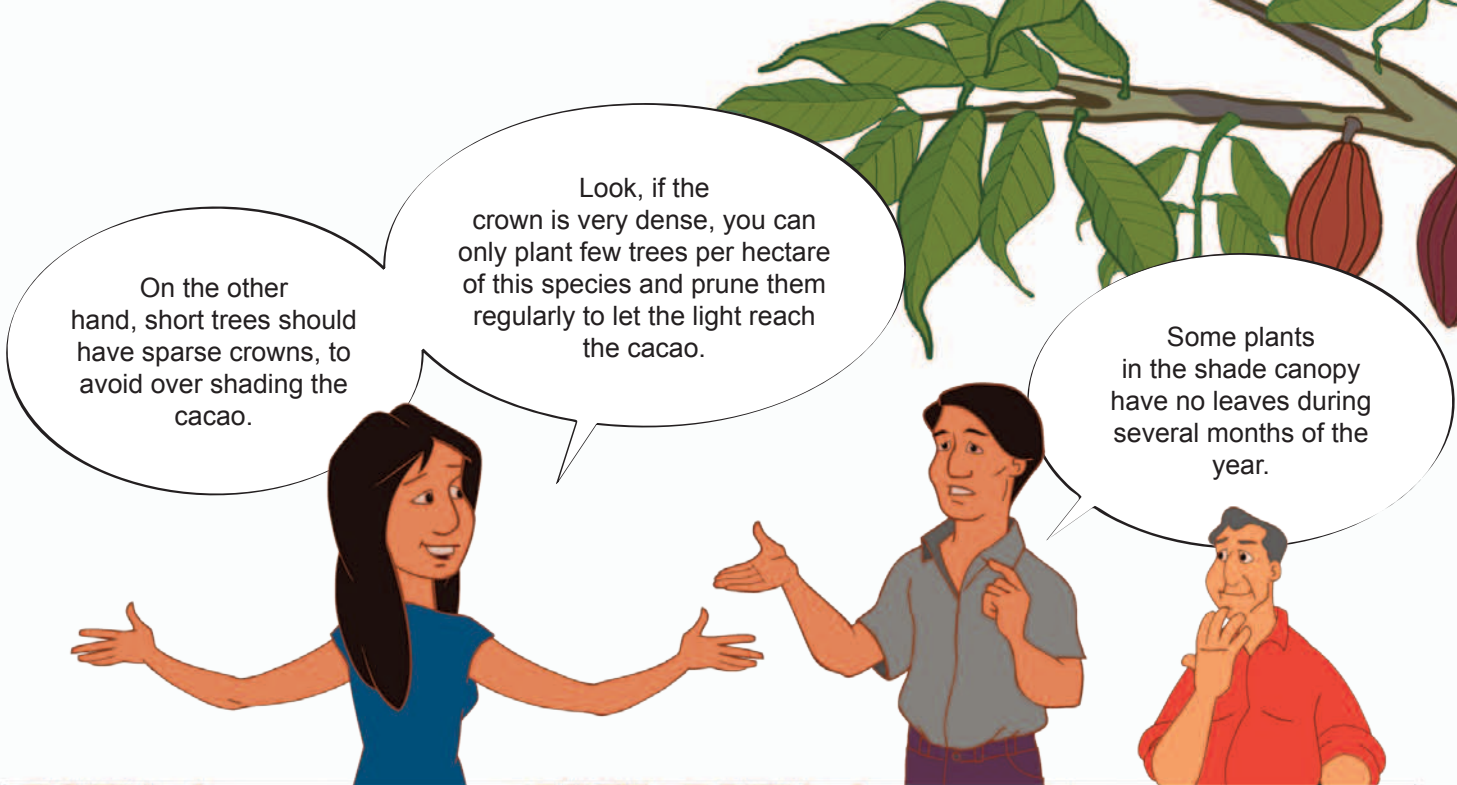
Speaking of heights, the reason I don't fly is that I have a horror of heights, I get dizzy and am sure to throw up.



The shade cast from a tall tree crown moves more quickly over the ground than the shade from a low tree.

We can take advantage of this. Tall trees may have heavy crowns and yet do not cast a lot of shade onto the cacao.






On the other hand, short trees should have sparse crowns, to avoid over shading the cacao.


Look, if the crown is very dense, you can only plant few trees per hectare of this species and prune them regularly to let the light reach the cacao.

Some plants in the shade canopy have no leaves during several months of the year.



Yes, hopefully they have no leaves during the months when the cacao is producing flowers and fruits, when more light is needed.

Let's take a short break. There is chocolate, coffee, pinole and donuts. Help yourselves.



I am going to use the break to go buy me a worm taco.

Bring me a double, but no onions please. I am going to visit my girlfriend and I want very fresh breath.

Improving the shade canopy

After lunch...





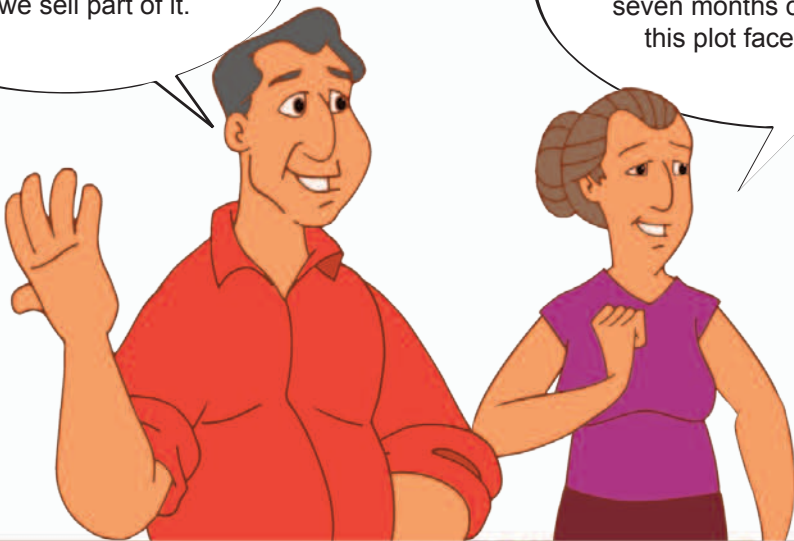
Glad to, Alberto. I like fruit trees and Gerardo likes timber trees.

I planted at least five species of fruit trees in the shade canopy.

The family, our domestic animals and the wild animals eat the fruit and we sell part of it.


Here the land has a moderate slope. The sun rises toward the south for seven months of the year and this plot faces the south,

so we have the sun facing us most of the year.




It rains here almost all year, but there is not too much cloudiness. It rains a couple of hours in the afternoon and the rest of the day it is quite sunny.


The soil of the cacao plot is never dry at any time of the year.




However, during the months at the end of the year, there is a lot of wind that comes from the northeast.



Tell me about it! In December I have to use Vaseline so that the wind does not mess up my crest.

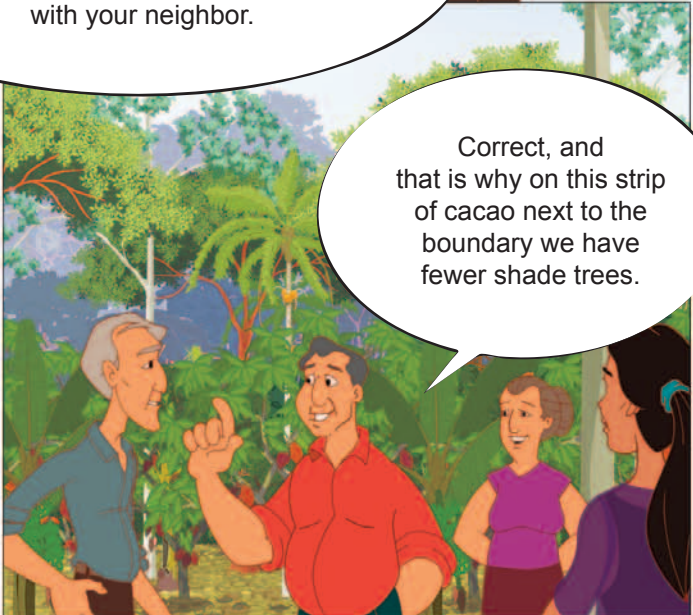


I have already planted a windbreak 150 meters long, just there, five meters from where the cacao begins.



I don't see hills or tall plants that would provide lateral shade at the edge of the cacao plot, with the exception of that large tree there, on the boundary with your neighbor.

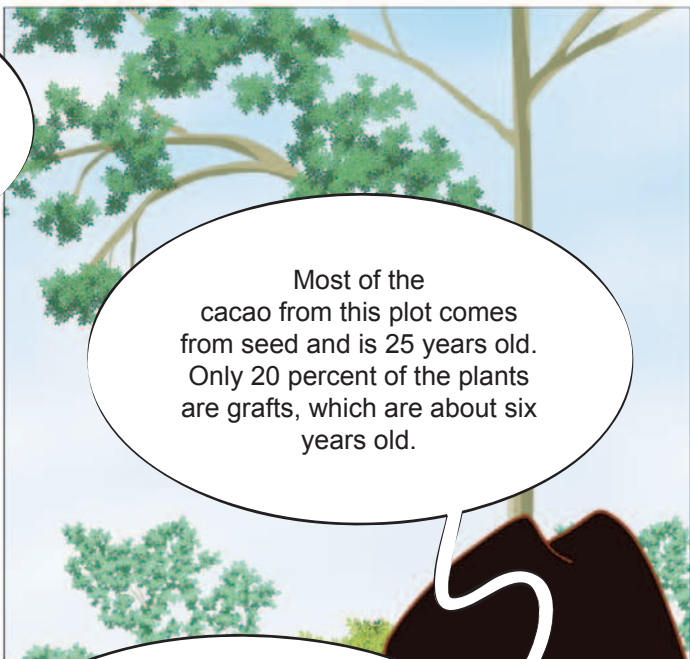
Every year we fertilize the soil with two thousand kilos of organic fertilizer per hectare.



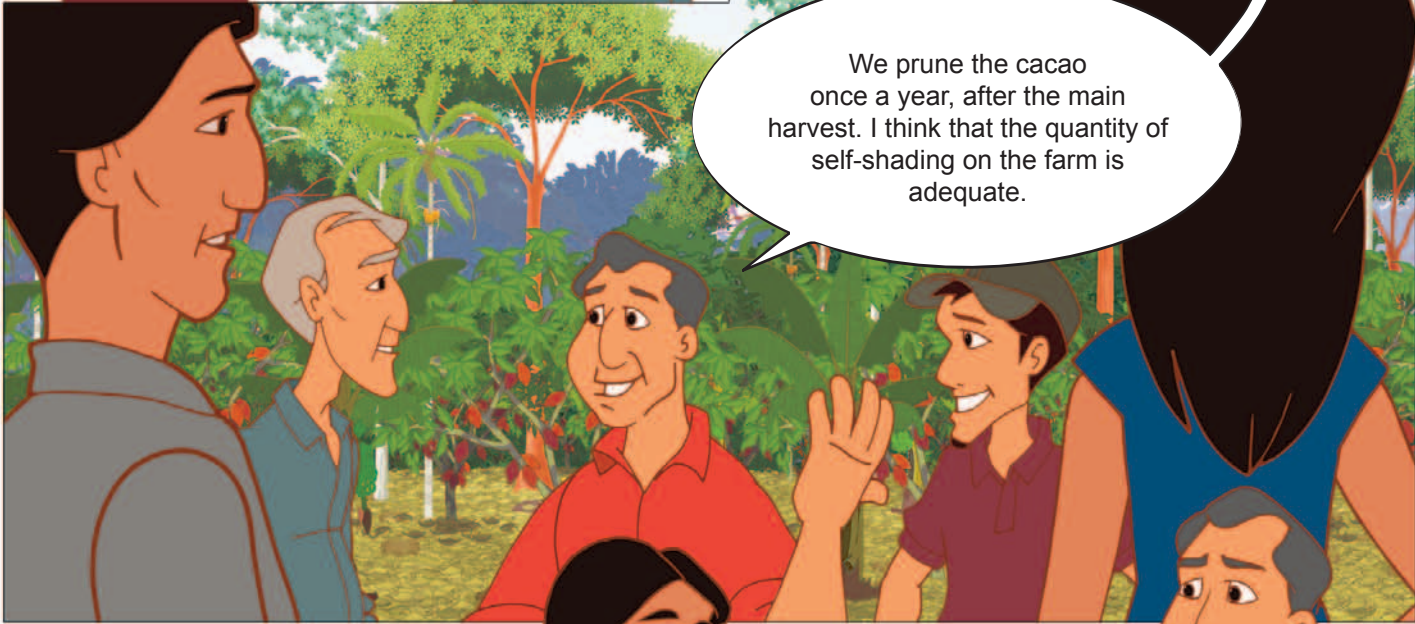
Correct, and that is why on this strip of cacao next to the boundary we have fewer shade trees.



I have told my neighbor Ramon that this large tree gives me a lot of shade and I cannot plant either timber or fruit trees on that part of the cacao farm.



Most of the cacao from this plot comes from seed and is 25 years old. Only 20 percent of the plants are grafts, which are about six years old.



We prune the cacao once a year, after the main harvest. I think that the quantity of self-shading on the farm is adequate.

When touring the plot, I saw several dense patches and some holes without shade.



Yes. In the patches with too much shade I will thin out about half of the trees in each patch.





To fill the holes without shade I am going to let the species of timber trees that come up on their own continue to grow.

In the largest hole, there at the end of the ravine, I am going to plant quality fruit trees.

As you see, the shade canopy of this cacao plot has planted fruit, timber species and various native forest trees.



The shade canopy has a total of:

150 plants per hectare, including:
50 banana plants.

50 laurel trees, a timber species that reproduces naturally here.

20 peach palm plants, a palm with edible fruits and delicious heart of palm.

20 monkey tail trees, a shade species that also provides edible fruits.

some coconuts and other native plants.



Some trees on this plot reach a height of 35 meters, but most measure between 10 and 20 meters high.



Here we find everything. Some species have narrow, open crowns; others, broad and dense.

There are tall trees with open crowns, others with dense crowns. One species has no leaves from February to May.



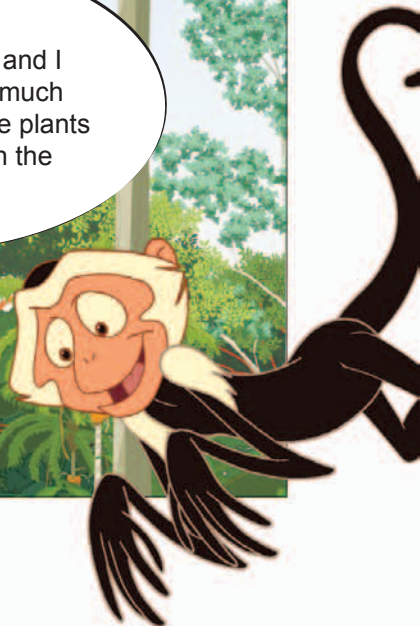
Although there are some problems in the distribution of the shade, I believe there is an adequate amount of shade.

The only argument Gerardo and I have is about how much timber, fruit and native plants we want to keep in the cacao plot.

We still don't agree.



Miriam, don't worry, we will surely reach a good agreement on this. Just be patient!





Very well, I think it is time to bring the meeting to an end. Now we must go to our own farms to diagnose and improve our shade canopies.

Goodbye everybody, and thank you for coming. The truck has arrived, so climb up in the back! Quit goofing around or you will hurt yourselves.

Not on your life! I am holding on to the rail so I won't get skinned up!

Be careful and make a beeline for home.

I don't know about the bees, but we animals have to get to our burrows!

Guide for diagnosing the shade canopy of a cocoa farm

The family

1. What do you want from the cacao farm? What goods and services do you want from the shade canopy? How much are you willing to invest to improve the farm?
2. Which of the six types of cacao farms does your farm most resemble?
 - a. Cacao without shade.
 - b. Cacao farm with one species that only serves for shade.
 - c. Cacao farm associated with other perennial crops.
 - d. Cacao with mixed shade.
 - e. Cacao farm under natural thinned forest or rustic cacao.
 - f. Cacao agroforests.

The site

1. Make a hand drawn map of the cacao farm.
2. Is the cacao planted on flat land or land with a steep, medium or slight slope?
3. Which direction does the slope face—for instance, north, south, east, west, northeast, northwest, etc?
4. How many months during the year does the sun rise toward the north and how many months toward the south?
5. In which months of the year do strong winds blow? From which direction do they blow? What species are used in this area for windbreaks?
6. In which months of the year is it quite cloudy?
7. Is soil fertility high or low?
8. Do you apply fertilizers to the cacao? Indicate which ones and how much per year (kilos, pounds, quintals or tons) per unit of area (acre, hectare, manzana, cuerda or other unit of measurement).
9. In which months of the year is the soil on the cacao farm dry because of lack of rain? Is irrigation available?
10. Are there hills or tall vegetation at the edge of the cacao farm that produces lateral shade on the cacao plot? How many hours per day does the cacao plot receive lateral shade?

The cacao

1. Is there little, adequate or too much self-shading in the cacao farm?
2. Is the cacao young, mature or old?
3. Is the cacao from seed, grafts or mixed? If it is mixed, what is the percentage of grafted plants?
4. At what distances and arrangements is the cacao planted? What is the number of plants per hectare?
5. In what phenology status (flushing of leaves, flowering, fruit enlargement, ripening fruit, resting phase) is the cacao at the time of the inspection?
6. How often are the cacao trees pruned? Once a year, every two years, infrequently?

The shade canopy

1. Indicate on the sketch of your cacao 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 those that come up on their own to fill the holes.
2. Inventory the species in the shade canopy. Note how many individuals there are of each species. For each tree, record the following characteristics:
 - a. Name of the plant.
 - b. Goods or services it provides.
 - c. Height of the trunk up to where the crown begins.
 - d. Height of the crown.
 - e. Width of the crown.
 - f. Whether the crown is sparse or dense.
 - g. Months of the year the crown is without leaves.
3. Determine whether these species or the number of plants per species is in line with what we expect from the cacao farm.

BIBLIOGRAPHY

- Beer, J; Muschler, R; Somarriba, E; Kass, D. 1997. Shade management in coffee and cocoa plantations. *Agroforestry Systems* 38:139–164.
- Schroth, G; Harvey, CA. 2007. Biodiversity conservation in cocoa production landscapes: an overview. *Biodiversity and Conservation* 16:2237-2244.
- Somarriba, E. 1994. Sistemas cacao-plátano-laurel: el concepto. CATIE, Serie Técnica, Informe Técnico #226. CATIE, Turrialba, Costa Rica. 33 p.
- Somarriba, E. 2004. ¿Cómo evaluar y mejorar el dosel de sombra en cacaotales? *Agroforestería en las Américas* 41/42:120–128.
- Somarriba, E. 2007. Cocoa and shade trees: production, diversification and environmental services. *Gro-Cocoa* 11:1–4.
- Somarriba, E; Andrade, HJ; Segura, M; Villalobos M. 2008. ¿Cómo fijar carbono atmosférico, certificarlo y venderlo para complementar los ingresos de productores indígenas en Costa Rica? *Agroforestería en las Américas* 46:81–88.
- Somarriba, E; Beer, J. 1994. Maderables como alternativa para la substitución de sombra en cacaotales establecidos: el concepto. CATIE, Serie Técnica, Informe Técnico #238. 34 p.
- Somarriba, E; Beer, J. 2011. Productivity of *Theobroma cacao* agroforestry systems with legume and timber shade tree species. *Agroforestry Systems* 81:109–121.
- Somarriba, E; Beer, J; Bonnemann, A. 1996. Arboles leguminosos y maderables como sombra para cacao: el concepto. CATIE, Serie Técnica, Informe Técnico #274. 56 p.
- Somarriba, E; Quesada, F. 2005. El diseño y manejo de la sombra en el cacaotal. Serie Técnica Manual Técnico 59, CATIE, Turrialba, Costa Rica. 55 p.
- Somarriba, E; Villalobos, M; Orozco, L. 2008. Cocoa in Central America. *GroCocoa (CABI)* 14:5–7.
Link: www.catie.ac.cr/pcc/inaforesta.

SCIENTIFIC NAMES OF PLANTS AND ANIMALS

- Basin The land that collects the rain water that drains into a river until it reaches its mouth at sea, lake or land.
- Black pod (*Phytophthora palmivora*), fungus that damages cacao fruit.
- Cacao (*Theobroma cacao*).
- Coconut (*Cocos nucifera*).
- Compass. Device with a magnetized needle that always points toward north.
- Gliricidia (*Gliricidia sepium*).
- Laurel (*Cordia alliodora*).
- Monkey tail (*Inga spp.*).
- Monilia (*Moniliophthora roreri*), fungus that damages cacao fruit.
- Peach palm (*Bactris gasipaes*).
- Perennials. Plants that live more than two years.
- Poro (*Erythrina poeppigiana*).
- Witches' broom (*Moniliophthora perniciosa*), fungus that damages cacao fruit.