



COLLECTION  
**PRO-AGRO**

# **cocoa**

**production and processing**

*Kokou Edoh Adabe & E. Lionelle Ngo-Samnick*



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# General

# information

Still called “food of the gods”, the cocoa tree (*Theobroma cacao* L.), of the Malvaceae family, is a tropical plant cultivated for its beans, from which cocoa powder and butter are extracted. There are three main varieties of cocoa: “Forastero”, usually yellow but occasionally red when the pod is ripe, “Criollo”, more sought after and more expensive, whose pods are red or red-orange when mature, and “Trinitario”, which is a hybrid of the two preceding varieties. “Forastero” is the most commonly grown variety in West and Central Africa, but its flavour is not as good as that of the other two varieties.

The cocoa bean is greatly appreciated for its aroma and its nutrients (phosphorus, magnesium, iron, zinc, manganese, copper, potassium, selenium, vitamins B2 and B3). When fermented and dried, it contains 50 - 57 % lipids, 10 % proteins, 12 % fibres, 8 % carbohydrate (starch), approximately 5 % minerals, etc.

As a cash crop, a cocoa plantation can last between 15 and 40 years. With the sale price per tonne varying between € 1,000 and € 2,000 (i.e. FCFA 656,000 – 1,312,000), cocoa constitutes a significant source of income for the small-scale operators who are responsible for the majority of worldwide production. Cocoa production is also a source of foreign exchange for producing countries. In 2012, worldwide production of cocoa reached 4 million tonnes. Chocolate is the most sought after derived product of cocoa. Its global trading generates a sum of € 76 billion (\$ 105 billion US).

Indigenous to the tropical forests of Latin America, the cocoa tree needs a tropical climate (hot and humid). The tropical countries situated around the equator are favourable for growing cocoa.

### **The three main production regions are:**

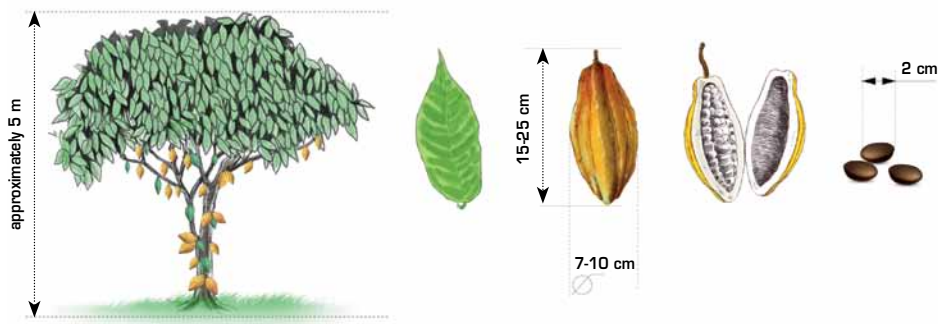
- The Gulf of Guinea (Côte d'Ivoire, Ghana, Nigeria, Cameroon, etc.)
- South America, Central America and the Caribbean (Brazil, Ecuador, Peru, etc.)
- South Asia and Oceania (Indonesia, Malaysia, Papua New Guinea, etc.).



# 1

## THE COCOA PLANT

The cocoa tree measures approximately 4 - 5 m; at 1 - 1.5 m in height, it subdivides into several branches with a very dense leaf system. The flowers form directly on the trunk and along the large branches, producing between 10 and 80 fruits, commonly called “pods”, containing 20 to 50 white beans.



### ↑ *The cocoa tree, the leaf, the pod and the beans*

The nursery produces young cocoa plantlets for the establishment of plantations. It is one of the prerequisites for a successful plantation and it helps to avoid the high mortality rate encountered when the seeds are sown directly in a field. There are three methods for propagating the planting material of the cocoa tree: grafting, taking cuttings and propagation by the beans, which is the simplest and most widely used method.



# 2

## THE NURSERY

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### 2.1 Setting up

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The nursery is set up 5 - 8 months before the plantation. It is usually located near an inexhaustible water source to facilitate watering. It must be as near as possible to the future plantation, to the village or to humus-bearing soil. It is also advisable to build it on well-drained land that is flat or only slightly sloping. Low-lying areas should be avoided. If necessary (e.g. if located on a steep slope), drainage ditches can be dug in the direction of the steepest slope.

The shade house should be made from wood or bamboo to a height of 2.5 m. It is covered with evenly distributed palm leaves or straw, allowing 50 % of the light to pass through. It is also necessary to have a cover on those sides exposed to sunlight.

Prepare the soil to be used to fill the sacks in which the beans will grow (humus-bearing, sandy-clay) by choosing surface soil, preferably under forest cover, while avoiding areas containing old cocoa trees or non-decomposed manure. If the soil is very heavy, mix 1 barrow-load of sand with 3 barrow-loads of black soil. Sift well.

Fill plastic sacks (polyethylene) with humus-bearing sand-clay soil. The bags should measure 15 x 25 x 10 cm and the lower half should be perforated beforehand.

Place the filled sacks onto the boards (10 sacks wide and 50 sacks long), which will be separated by 60 cm rows and 1 m from the sides of the nursery to allow easy access. Keep the sacks upright using bamboo supports attached horizontally to small vertical stakes.

Build a fence around the shade house to protect the young plants from rodents. For a one hectare plantation, allow 80 - 100 m<sup>2</sup> for the nursery (2,000 plants), i.e. 60 or 70 ripe pods.





↑ **Young cocoa plants  
under the shade house**

## 2.2 Seeding

To obtain good productivity, use seeds from the most productive trees or pods of improved varieties supplied by research centres. Remove healthy pods (those displaying no signs of rot, insect damage or spots, etc.) from the productive trees shortly before their optimum point of maturity (colouring over three-quarters of the pod).

After harvesting or receiving the chosen pods, open them carefully without damaging the beans. Dispose of the 3 sterile beans at the base of the pod.

Clean the extracted beans thoroughly in water then scrub them with fine sand or sawdust to remove the mucilage (whitish pulp). Rinse them again in water, removing any beans that are flat, too small, sprouting or that float in the water.

**The beans must be sown within three days of being harvested as the seed loses its ability to germinate if it stays out of the pod too long.**

The day before sowing, water the bags filled with soil. Sow one bean at the centre of each bag, with the fatter end of the seed pointing down or flat, so that the root is upright. Push the seed to a depth of 1 cm. Cover it with soil and press it lightly with the fingers, then water abundantly.





Germination will begin around the fifth day and the plants will remain in the nursery for 6 - 8 months.

## 2.3 Maintenance

Water the nursery every day (early morning or evening) for the first 15 days after sowing, then every other day – but not excessively – to ensure that the bags of soil remain moist.

Weed the bags and the rows between the boards to eliminate plants that will compete for water and nutrition.

Replace missing plants 2 weeks after sowing by repeating the bean selection process. It is possible to repeat the operation 2 - 3 times.

If necessary, begin fungicide treatment with a “mixture of Metalaxyl and copper (e.g.: Ridomil Gold Plus 66 WP at a ratio of one bag per 15 litre spray of water)” when the plants have 2 - 4 leaves, then apply every 21 days. Protect the plants against insects by spraying insecticide once a month (e.g.: Deltamethrine [75 ml of Decis 12.5 EC for 15 litres of water] alternating with Imidaclopride/Lambdacyhalothrine [50 ml of Parastar, Plantima 30 SC, Confidor 200 SL, Confidor 200 OD, Miprid 200 SL, Contras 200 SL, Tropi-cao 200 SL, ao-net plus 200 SL, Thiofor-extra 200 SL for 15 l of water]).

**Do not water the plants for two days after the treatment.**

Regularly group plants of the same size together on the same board. Gradually reduce the amount of shade one month before the transplantation to allow the plants to get used to brighter sunlight.

Kept in good conditions, plants aged 5 - 6 months should measure at least 50 cm when they are planted.



# 3

## PLANTATION

### 3.1 Choice of plot

The plot should have easy access and be located near a water source to facilitate watering and phytosanitary treatment. The average temperature of the area must be between 24 and 28 °C and the pluviometry must be between 1,200 and 2,000 mm distributed relatively evenly throughout the year, with a dry season no longer than three months.

Ideally, choose soil that is rich, well-drained, deep, loose on the surface, sand-clay and with a water table more than one metre deep. Cocoa prefers acidic soil (pH below 6). Use trees as indicators of soil quality, such as *Ceiba pentandra* (kapok, Doum), *Pycnanthus angolensis* (Ilomba, Eteng), *Triplochytan scleroxylon* (Ayous), *Ficus mucosa* (fig, Tol). Give preference to previously forested areas, reforested areas, old coffee or cocoa plantations.

**Avoid land on hilltops or in lowlands (hydromorphic or marshy) and stony soil. Avoid steep slopes (more than 10 % gradient). In the case of uncultivated land, avoid soil that has hosted several cycles of tubers, such as cassava root, cocoyam or sweet potato, which will have caused chemical degradation of the soil.**

### 3.2 Preparation of the site

Clear the land three to six months before planting the cocoa trees. To do this:

- Demarcate the plot by creating paths 2 m wide around the selected area.

>>> For small-scale farmers, prepare 0.5 hectare plots every year. For greater profitability, operations over at least 1.5 hectares are preferable.

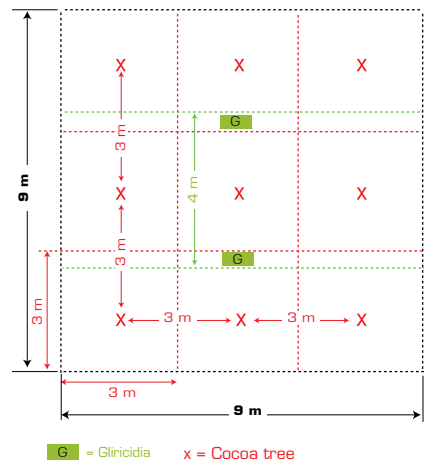
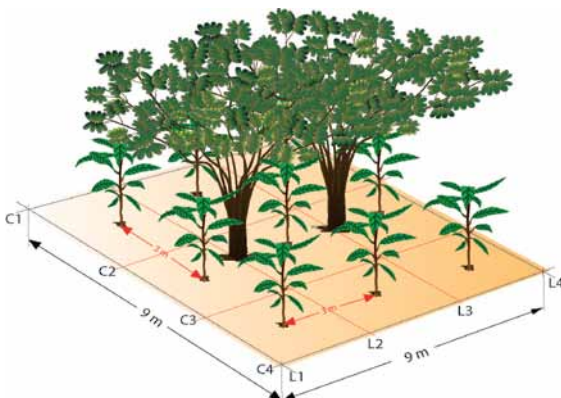


>>> For larger operations, create blocks of 4 to 5 hectares. Create tracks between the blocks and around the plantation for ease of access.

- Select and then mark those trees favourable for or compatible with cocoa trees, at a rate of 35 to 40 trees per hectare.
- Weed and clear the land, then remove brush that is of no particular use and offers no protection against the sun. Larger trees that can offer better protection for cocoa trees must be preserved.

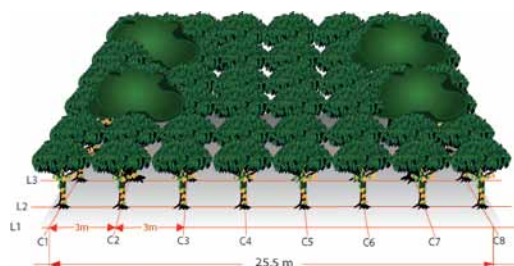
Trees such as *Piptadeniastrum africanum* (Atui, Dabema), *Bombax buonopozense* (Kapokier, Essodom), *Cola sp.* (*Garcinia cola*, *Cola nitida*) are not particularly suitable for cocoa trees. However, they can be retained if necessary according to the specific needs of the farmer.

- Mechanised pruning, clearing and swathing must be carried out carefully to avoid compressing the soil.
- For fallow land, introduce leguminous shrubs (*Gliricidia spp.*, *Albizia spp.*, *Leucaena leucocephala*) every 4 m to restore the soil or income-generating plants (plantain, *Dacryodes edulis* or butter fruit, avocado, etc.) to create shade for at least 2 years. This shade must be planted between the lines in staggered rows, taking account of the density of the cocoa trees. Tubers are not recommended.

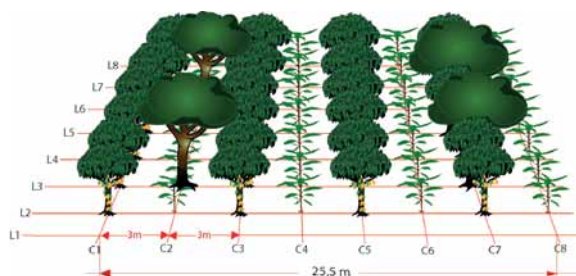
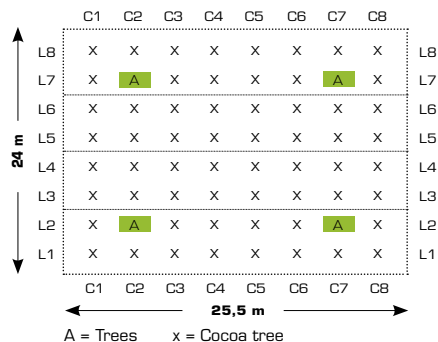




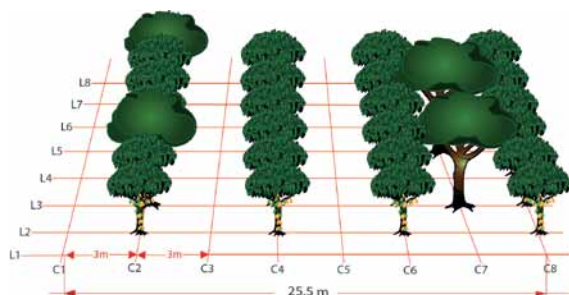
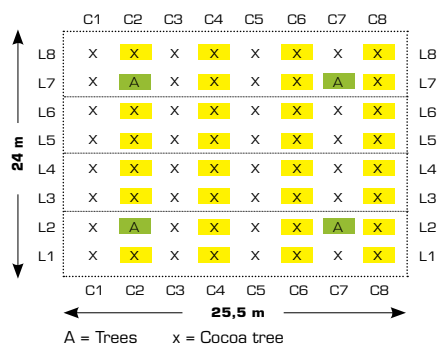
- In the case of an old cocoa tree, regeneration by grafting onto trees that have been cut back or gradual and partial replanting in strips under the old cocoa trees (followed by the gradual removal of the old trees in three years) should be given priority.



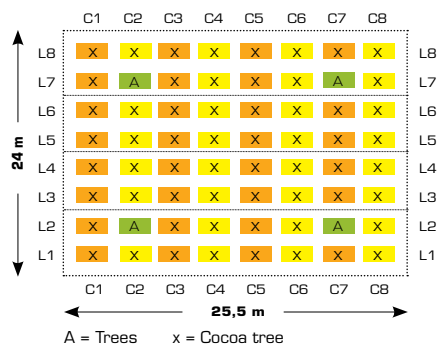
**Year 0**



**Year 1**

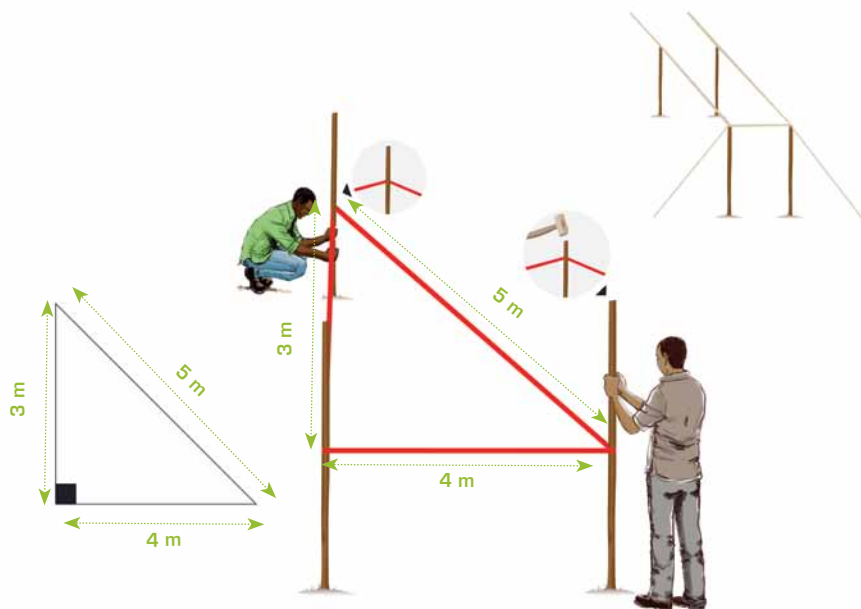


**Year 4**





Staking consists of marking out the future position of each cocoa tree with stakes or posts in order to observe planting densities, use the maximum capacity of the soil and facilitate maintenance. The “3, 4, 5 process” is employed by using three lengths of bamboo measuring 3, 4 and 5 m to form a right-angled triangle, the apex of which will be used as a point of reference.



### ⬆ **Right angle staking system: “3, 4, 5 process”**

The lines are traced using a length of string following a 3 m x 3 m planting plan for a density of 1,111 plants per hectare.

The pathways outline planting lines for the cocoa trees on a strip one metre wide. Establish windrows between the lines of cocoa trees to facilitate transplanting, maintenance of the lines of cocoa trees and good crop development.

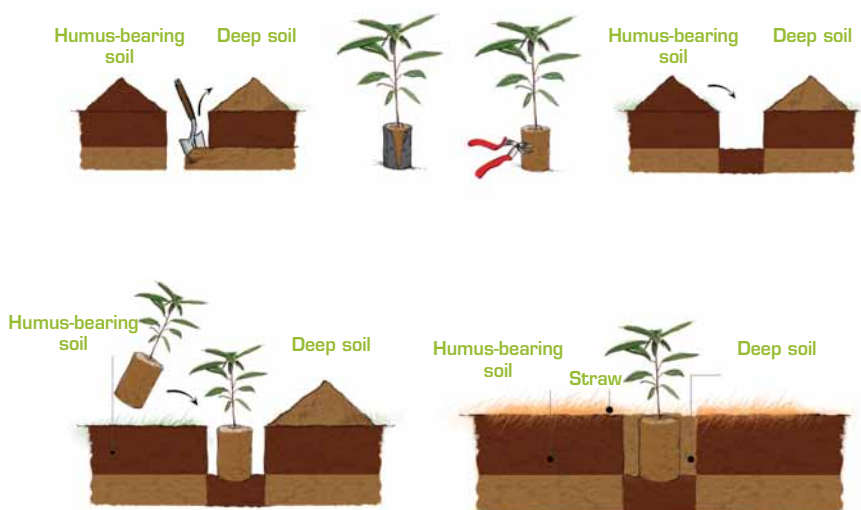


### 3.3 Planting

At the start of the rainy season, make holes measuring 40 x 40 x 40 cm at the staked-out positions, taking care to separate the surface soil from the deeper soil. If possible, insert some thoroughly decomposed manure, compost or humus-bearing soil into the bottom of the hole.

The plants must be planted as soon as they arrive on site. Give preference to cooler times of day (before 08.00 hrs and after 16.00 hrs).

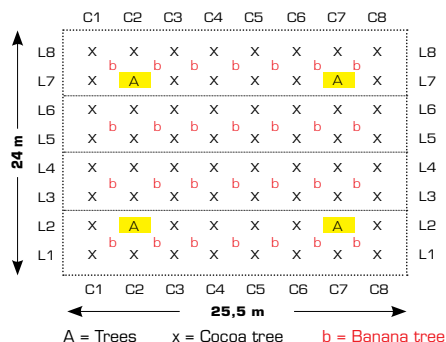
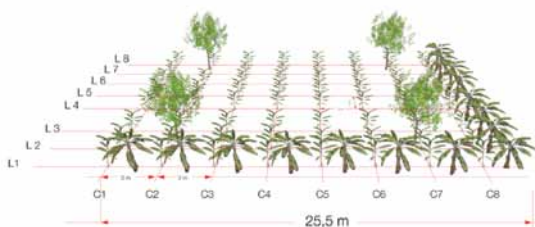
- Select the healthiest and most robust plants from the nursery
- Place them at the side of the holes in which they are to be planted
- Remove the black soil, stones and pieces of wood from the roots and place the plant at the bottom of the hole
- Carefully cut away and remove the plastic bag
- Prepare the plant by removing any roots sticking out of the clod of soil, as well as the first leaves situated just above the clod, while cutting the bottom of the taproot, often rolled up at this level (plastic and earth) approximately 2 cm from the base.



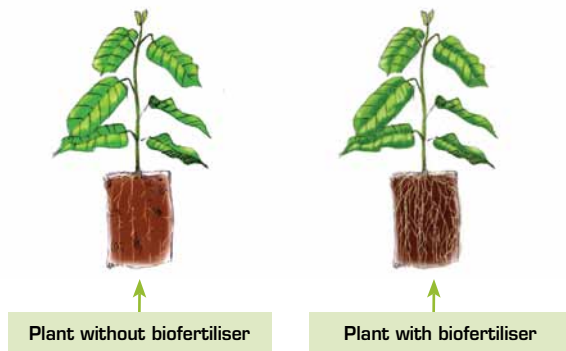
#### ↑ How to plant young cocoa trees



It is advisable to diversify with fruit trees to ensure the profitability of the operation, to allow for on-farm consumption and to reduce risks related to the volatility of cocoa prices.



Biofertilisers can be used for growing, potting, planting and transplanting mixtures.



- Pack down the earth, place the cocoa plant vertically with the clod of earth in the centre of the hole
- Cover the hole with the rest of the earth and press it down firmly, taking care to keep the collar of the young plant above the level of the soil. The collar designates the point at which the root becomes the aerial stem
- Even out the soil to avoid depressions around the plant in which rainwater could stagnate
- After planting, it is helpful to place plenty of mulch all around the young plant while keeping the neck free to maintain soil moisture.



# 4

## MAINTENANCE OF THE COCOA TREE

**Maintenance involves weeding, pruning, regulating the shade, fertilising and plant health care.**

### 4.1 Replacing plants and regulating shade

Replace plants that are dead, damaged or have not transplanted well to ensure uniformity of the plantation.

During the first year, allow 50 % of the total light to pass through. From the third year, gradually increase the amount of light from 50 to 75 % by removing leaves and branches from surrounding trees.

### 4.2 Weeding

At least three weeding operations per year are required to ensure proper flowering and a good harvest. Ideally, follow the weeding by hand with a chemical weed killer. Chemical weeding should be done when the weeds measure approximately 30 cm: use glyphosate (Kalash 360 SL, Glyphader 360 SL, Roundup 360 SL, Bifaga 360 SL, Glyphalm Heros 360 SL at a rate of 100 - 130 ml per 15-litre sprayer can of water).

**Do not use a chemical weed killer during the rainy season**



Weeding by hand



Chemical weeding



Well established adult plantation

### ↑ *Well established adult plantation*

**Certain types of soil preparation, particularly ploughing or digging, must be prohibited to protect the roots.**



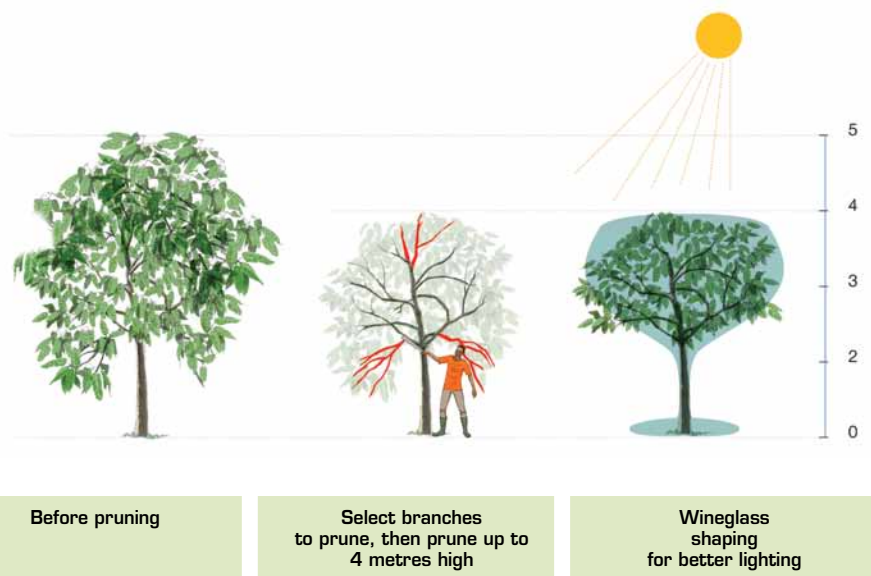
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## 4.3 Pruning, sanitary harvesting and staking

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To maximise production of the cocoa tree, cut the trunk of the tree at approximately 1.50 m above ground to obtain a crown with 5 branches, which improves flowering.

Every 2 to 3 months, use pruning shears to remove the suckers and any secondary offshoots growing from the trunk. Also remove any parts affected by insects, disease or parasitic plants.



Remove dry branches, rotten or dried out pods (cutting the stem of the pod without damaging the trunk); collect all of the debris (pods or husks on the ground) and cover it with a pile of dead leaves, so that it can decompose on the spot without spreading diseases.

Provide stakes for certain plants so that they do not give way under the weight of the pods. Drain the water if there is stagnation in the plantation.

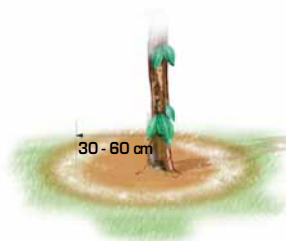


## 4.4 Fertilisation

The effect of the fertilisers depends on the soil conditions and the age of the plantation. Chemical fertilisers are effective and their use is profitable in well-run plantations. One month after pruning, spread it in a circular band between 5 and 30 cm from the base of the plant in the first year of the plantation, then in a band between 30 and 60 cm after 2 to 3 years and between 60 cm and 1 m from the fourth year. Cover the fertiliser with a thin layer of soil to avoid it being lost through water run-off.

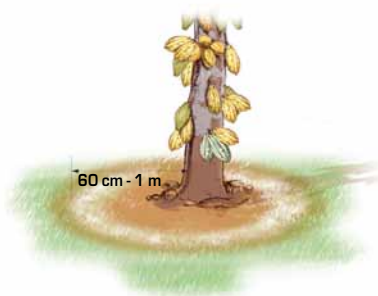


Initial planting



Super triple phosphate –  
100 g per tree twice a year

Planted 2 – 3 years



0-23-19+10 Cao+5 Mgo –  
150 to 200 per tree per year

Planted 4 years +

### ↑ *Changes in the spread of fertiliser around the cocoa tree*

The cocoa tree rarely needs nitrogen (N), but requires a lot of phosphorus, potassium and boron.



# 5

## FIGHTING COCOA DISEASES AND PARASITES

The solutions recommended here integrate chemical control, agricultural or agronomic practices and the use of resistant planting material to provide the cocoa crop with effective protection.

### 5.1 Cocoa diseases

The most dangerous diseases are viral diseases such as swollen shoot virus and fungal diseases such as brown rot.

#### Summary of principal diseases encountered and proposed solutions

Symptoms	Diseases and causes	Cultural control	Chemical treatment
<ul style="list-style-type: none"> <li>Pods with brown spots hard to the touch, covered with a whitish layer of spores</li> <li>Cankers on the plant body (trunk, branches, twigs).</li> </ul>	<p>Brown pod rot, caused by <i>Phytophthora sp.</i> (<i>P. palmivora</i> and <i>P. megakarya</i>).</p> <p>Virulent in poorly aerated plantations, it appears during the rainy season.</p>	<ul style="list-style-type: none"> <li>Sanitary harvesting of damaged young pods</li> <li>Regulating the shade by pruning the crown and aeration</li> <li>Regular maintenance of the plantation and breaking the pods outside of the plantation.</li> </ul>	<p>In the rainy season, spray the pods with:</p> <ul style="list-style-type: none"> <li>a mixture of Metalaxyl and copper (Ridomil Gold Plus 66 WP with a dose of 1 sachet per spray of 15 litres of water) once every 3 weeks (i.e. 4 - 6 applications per year) or</li> <li>copper (Cacaobre 50 WG, Nordox 75 WG, Funguran-OH 50 WP or Kocide 2000 with a dose of 1 sachet per spray of 15 litres of water) once every 2 weeks (i.e. 6 - 8 applications per year).</li> </ul> <p>N. B. For each application, 15 - 25 sprays of 15 litres are applied per hectare.</p>



<b>Symptoms</b>	<b>Diseases and causes</b>	<b>Cultural control</b>	<b>Chemical treatment</b>
<ul style="list-style-type: none"> <li>• Swollen stems</li> <li>• Reddish stripes on the yellow leaves</li> <li>• Yellowing along and between the veins</li> <li>• Deformation and reduced size of the pods.</li> </ul>	<p>Badnavirus – a viral disease transmitted by insects hosting the virus.</p>	<ul style="list-style-type: none"> <li>• Planting tolerant varieties</li> <li>• Isolate healthy plants using plants that are immune to the virus</li> <li>• Rapid removal and destruction of diseased plants and their immediate neighbours.</li> </ul>	<p>Possible use of insecticides to eliminate the vectors.</p>
<ul style="list-style-type: none"> <li>• Pods with brown bruises soft to the touch</li> <li>• Pods turning black or necrotic.</li> </ul>	<ul style="list-style-type: none"> <li>• Black rot caused by <i>Botryodiplodia theobroma</i></li> <li>• Mealy pod rot, anthracnose caused by <i>Lasiodiplodia spp</i>, <i>Colletotrichum</i>, etc.</li> </ul>	<p>Prune and sanitary harvest of diseased pods.</p>	<p>Chemical treatment ineffective.</p>
<ul style="list-style-type: none"> <li>• Rapid drying of the tree due to the attack on the roots; the leaves remain attached</li> <li>• No living suckers at the base of the tree</li> <li>• Appearance of vertical cracks and splits in the bark of the collar</li> <li>• Extension of the disease in spots.</li> </ul>	<p>Rot caused by <i>Armillariella mellea</i> and <i>Fomes sp</i>. Particularly affects plantations in which the stumps of old forest trees and/or those used for shade have been left.</p>	<ul style="list-style-type: none"> <li>• Carefully uproot the affected trees. Take them away from the plantation and burn them</li> <li>• Remove or poison the stumps.</li> </ul>	<p>No chemical treatment.</p>
<ul style="list-style-type: none"> <li>• Drying of several branches and lack of leaves</li> <li>• Living suckers at the base of the tree</li> <li>• Deterioration and drying up of the foliage from top to bottom.</li> </ul>	<ul style="list-style-type: none"> <li>• Tracheomycosis to calonectria (<i>Calonectria sp.</i>, <i>Colletrichum sp.</i>)</li> <li>• Appears after mirid attacks.</li> </ul>	<ul style="list-style-type: none"> <li>• Removal of diseased parts</li> <li>• Eventual replacement of the tree with a healthy plant.</li> </ul>	<p>No chemical treatment.</p>

*N. B. Fungicidal treatment must begin as soon as the first signs of rot appear.*





## ↑ *Cocoa diseases caused by parasites*

### 5.2 Cocoa parasites

The main harmful parasites are mirids and borers of stems and branches. There are also leaf-eating caterpillars, psyllids, scales, *bathycoelia Thalassina* (cocoa shield bug) and *Helopeltis*.

Treatment against insects is often applied by spraying. Although expensive, the use of a fogger makes the treatment more effective, as it enables the whole tree to be treated easily, requires less chemical, less time and less water than the spray gun (10 l with a fogger against 15 l with a spray gun).

### ↓ *Summary of harmful parasites and proposed solutions*

Symptoms	Parasites	Cultural control	Chemical treatment
<ul style="list-style-type: none"> <li>• Blackish marks on the pods</li> <li>• Dried up leaves attached to the branches</li> <li>• Formation of cankers, young pods drying up and falling</li> <li>• Splits in lignified wood.</li> </ul>	<p>Mirids or capsids are bugs (pentatomidae), the most active of which are <i>Distantiella theobroma</i>, <i>Sahlbergella singularis</i> and <i>Helopeltis</i></p>	<ul style="list-style-type: none"> <li>• Prune suckers;</li> <li>• Prune the crown to maintain good shade</li> <li>• Sanitary pruning of branches attacked by insects (cankers, etc.).</li> </ul>	<p>Treat with insecticides Imidacloprid/ Lambda-cyhalothrine (50 ml of Parastar or Plantima 30 SC for 15 l of water) at a rate of 2 applications per year in intervals of 2 months (June/July and August/September for Cameroon). Alternating with a treatment in November of Thiamethoxam (4 g of Actara 25 WG for 15 litres of water).</p>





## Summary of harmful parasites and proposed solutions

Symptoms	Parasites	Cultural control	Chemical treatment
White marks on the extremities of young shoots, on flowers and flower pads.	Psylles ( <i>Tyora tessmanni</i> ). Very evident in young plantations.		During the 1 <sup>st</sup> year, a monthly application of the insecticide Thiamethoxam (4 g of Actara 25 WG for 15 litres of water) alternating with the insecticide Imidacloprid/ Lambda-cyhalothrine (50 ml of Parastar or Plantima 30SC for 15 l of water).
<ul style="list-style-type: none"> <li>Discolouring of leaves then yellowing and stain</li> <li>General rusty appearance before falling.</li> </ul>	Thrips ( <i>Solenothrips rubrocinctus</i> ). Frequent during period of water stress.		
Shredded or damaged leaves leading to rapid defoliation.	Leaf-eating caterpillars.	Remove the insects by hand.	From the 2 <sup>nd</sup> year, the treatments against mirids will be enough to control these defoliating insects.
<ul style="list-style-type: none"> <li>Small perforations in the pods</li> <li>Early yellowing of the pods.</li> </ul>	Pod borers ( <i>Conopomorpha cramerella</i> ) encouraged by host plants such as the kola tree ( <i>Cola nitida</i> ) or the rambutan tree ( <i>Mephelium sp.</i> )	<ul style="list-style-type: none"> <li>During the low production season, remove pods measuring more than 5 cm</li> <li>Burn the pods to break the insect cycle.</li> </ul>	No chemical treatment.
<ul style="list-style-type: none"> <li>Dried up leaves, branches and stems leading to the rapid ageing and death of the cocoa tree</li> <li>Presence of round holes with sawdust.</li> </ul>	Borers and wood miners ( <i>Tragocephala sp.</i> )	<ul style="list-style-type: none"> <li>Prune dead branches</li> <li>Plantation maintenance.</li> </ul>	No chemical treatment. On request, treat the soil around the foot of each tree within a radius of 50 cm with Chlorpyrifos-ethyl (100 ml of Dursban 4E, Pyricol 480 EC).



If mistletoes are found on the cocoa tree, remove them immediately.



Thrips	Mirids	Mirid waste on pod	Psylles	Anomis Leona Leaf-eating moth
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### ↑ *Insects harmful to the cocoa tree*

Activities		January	February	March	April	May	June	July	August	Sept.	October	Nov.	Dec.
Setting up	Setting up the nursery								●	●	●	●	
	Developing the site (clearing, etc.)										●	●	●
	Staking out • clearing paths • digging holes	●	●	●									
	Planting (in the rainy season)				●	●	●	●	●				
Setting up	Weeding (by hand, the chemical treatment with 100 ml of Roundup 300 SL per spray gun)			●	●			●	●			●	
	Sanitary harvest		●										
	Treatment against insects						●	●	●	●			
	Maintenance pruning				●	●	●	●					
	Fertilisation (after the onset of the rainy season)					●	●						
	Treatment of brown rot (rainy season)					●	●	●	●	●	●		
	Treatment for mirids (50 ml of Parastar for 15 L of water)							●	●	●			
	Harvest (depending on appearance of pods)		●	●	●				●	●	●	●	●

### ↑ *Operational calendar for a cocoa plantation in the forest region of Cameroon (with two rainy seasons)*



# 6

## HARVEST AND POST-HARVEST OPERATIONS

**These are determinant factors for obtaining marketable cocoa of high quality.**

### 6.1 Harvest

The first harvest takes place after approximately three years (hybrid/improved variety) or 4 – 5 years (traditional variety coming from the nursery) after planting. The cocoa tree can produce twice a year for more than 30 years. Harvest the pods at regular intervals of 10 - 15 days (do not go over three weeks).



Vermilion



Orange or red



Yellow

Harvest the pods at optimum maturity (when the fruit turns three quarters yellow, vermillion, orange or red, depending on the pod colour of the variety).

Harvesting is done by cutting the stalk with a machete, a pruning pole, pruning shears or a sickle. Avoid damaging the flower cushions which will produce the flowers and fruits of the subsequent harvests.

Next, remove the pods from the plantation and transport them to the pod-breaking site.



Machete



Pruning shears



Pruning pole



Sickle



Never harvest by hand

 **Harvesting the pods**



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## 6.2 Breaking the pods

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The pods are broken no more than 5 days after harvesting. Separate the healthy pods from the damaged pods to differentiate between the grades. Open the pods with sticks that have no sharp edges so as to extract the seeds without damaging them.



### *Breaking the pods*

When breaking the pods, any defective beans, the rachis and cortex debris must be removed.

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## 6.3 Fermentation

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Fermentation is essential for rapid reduction of the beans' ability to germinate and to develop the flavour and aroma precursors of the chocolate. The freshly extracted beans are placed on banana leaves (or cocoyam leaves) inside baskets, wooden boxes, clean fermentation tanks or on the ground in the fermentation area and under shelter. The beans are then covered with leaves and left to ferment for 4 – 7 days. Every other day (2nd and 4th day), stir them around and check the humidity.



**Fermentation depends on the quality of the pulp. Pulp from unripe or overripe pods will not ferment well.**

The beans then change colour (from white/mauve to brown). The inside is light brown or reddish. Well-fermented beans have a shiny appearance, without mould and their cotyledons break easily. They release a chocolate aroma.



## 6.4 Drying

After fermentation, remove the remains of the pulp by washing the beans or mixing them with sawdust and dry banana leaves.

The beans are then dried naturally or artificially. Natural or solar drying is the simplest and most popular method and takes 8 – 15 days.

In small operations, the beans are often spread out on bamboo or straw mats placed in the sunlight, on sheets of black plastic, etc. Stir them around frequently for 5 days. Sort them to remove defective or flat beans. Once dry, their average weight is one gram with a moisture content of approximately 7 %. Place them in a dry, sheltered and well-aerated spot to protect them from damp (rain, humid nocturnal air) and avoid the risk of mould developing.



### ⬆ *Mixing the beans on a screen during traditional drying*

Natural drying can be optimised by using improved driers that give better results. Depending on the model, the beans can easily be sheltered from rain or protected by different structures.

In particular, do not dry the beans at the side of asphalt roads.

The **autobus drier** has a fixed frame with rails on which the drying screens slide.



The **mobile roof drier** has a fixed drying area with a roof that can be removed depending on the weather.





The **tent drier** is covered by a transparent sheet of plastic, and the drying area is black to conserve the energy that is gradually expended during the night.



The **greenhouse drier** reduces the need for handling and enables large quantities of beans to be dried. However, it requires a significant investment and it is necessary to provide a ventilation system (based on the convection principle) and a system for controlling the drying parameters.



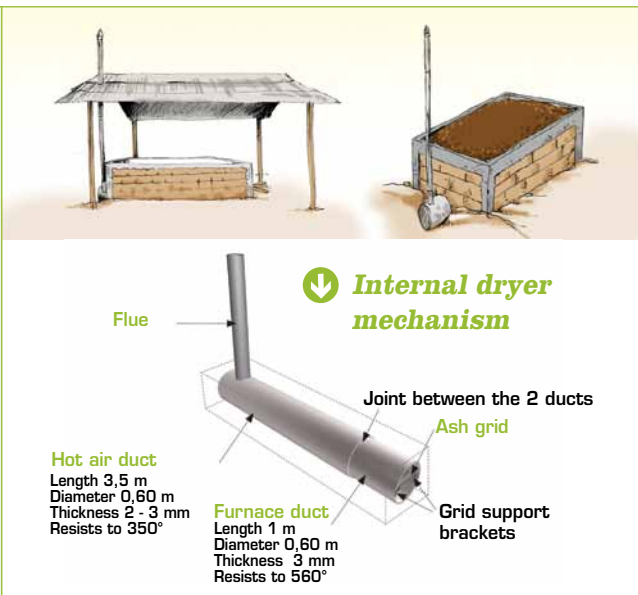
To reduce drying time, it is possible to use artificial driers, with hot air for between 15 and 48 hours. The heat is produced by a wood- or gas-fired furnace. Make sure that the beans do not come into contact with the smoke or with the heating plate. There must be a system for ventilation and controlling the parameters, particularly the temperature, as the taste qualities of the cocoa beans change above 55 °C.

To be avoided:  
kiln drying  
(contact with  
the smoke).





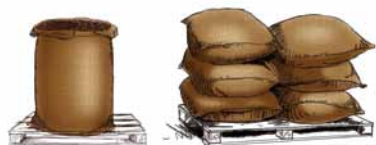
Improved hot air driers (air heated by furnace) insulated from the smoke by a flue are preferable. A heat-conducting material is heated, the ventilators capture the heat from this material and convey it to the cocoa beans, which are placed on a sort of screen or shelf.



### Regardless of the drying method used:

- make sure the product to be dried is properly fermented
- sort the beans to remove dirt, impurities and any beans that are flat or sprouting
- use the following measurements for the layer to be dried: 4 - 6 cm for natural drying and 5 - 10 cm for artificial drying
- monitor the cocoa by regularly taking a sample of a few beans towards the end of the drying process. Crack them with your hand and split some of them to ensure that the cocoa is completely dry both inside and outside.

## 6.5 Storage



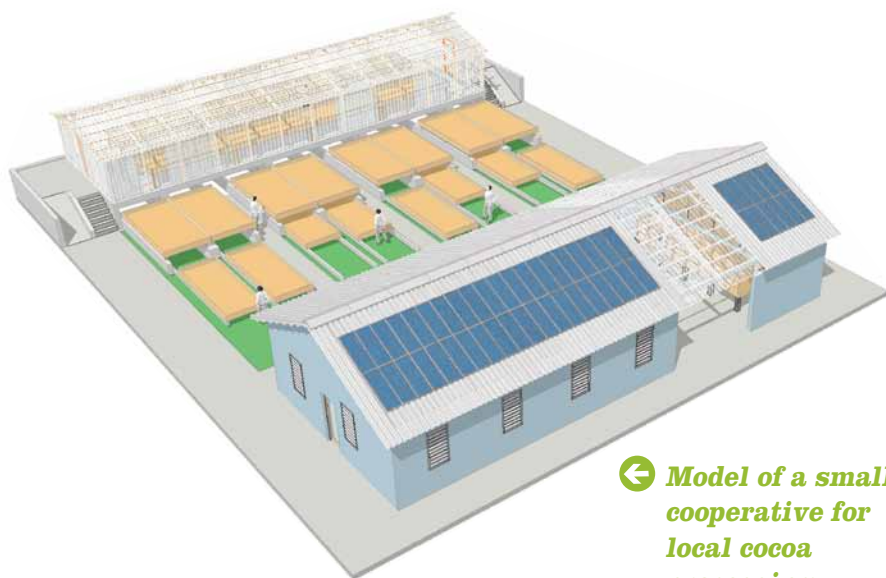
### ↑ Storage in jute bags

Storage involves keeping the cocoa completely dry to avoid mould, insect damage and the formation of free fatty acids.

The dried cocoa beans are placed in jute bags on a pallet to avoid contact with the ground and walls. The storage location must be dry, clean, well-aerated and protected from rodents and humidity to ensure the quality of the product.

In the case of insect attacks, fumigate the storage area.





← **Model of a small cooperative for local cocoa processing**

## 2. DRYING AREA

### 2. DRYING

2.1 NATUREL SOLAR DRYING  
"Autobus" sliding wooden driers

## 1. PRODUCTION AREA



1.2 FERMENTATION AREA  
(Multiple wooden boxes covered with banana leaves)

1.1 STORAGE AREA  
Cocoa pod inlet

1.3 PROCESSING AREA  
- Storage  
- Roasting  
- Winnowing  
- Mixer/Moulding  
- Press  
- Tempering/moulder

1.4 SHOP  
- Sales area  
- Storage

GREENHOUSE

DRYING AREA

PRODUCTION UNIT



# 7

## USE OF BY-PRODUCTS

**The cocoa bean is composed of two parts: the non-edible part (tegument or shell) and the edible part (cotyledons or seeds).**

**In total, 70 % of the weight of the pod is made up of the shell. Shells can be used as fertiliser, animal feed or even fuel.**

### 7.1 Organic fertiliser

**After breaking the pods, collect the empty shells and crush them:**

- if possible, mix 3 parts of crushed shells with one part of decomposing household waste (preferably livestock waste)
- stack the mixture in piles 2 m wide and 1 m high
- cover the piles to maintain a high temperature and a high percentage of relative humidity required for the decomposition of the shells and the destruction of brown rot pathogens
- turn the pile every 3 weeks for 3 months. Water if necessary.





After three months, the material becomes dark. The compost is then ready and can be used as an organic fertiliser rich in mineral elements.

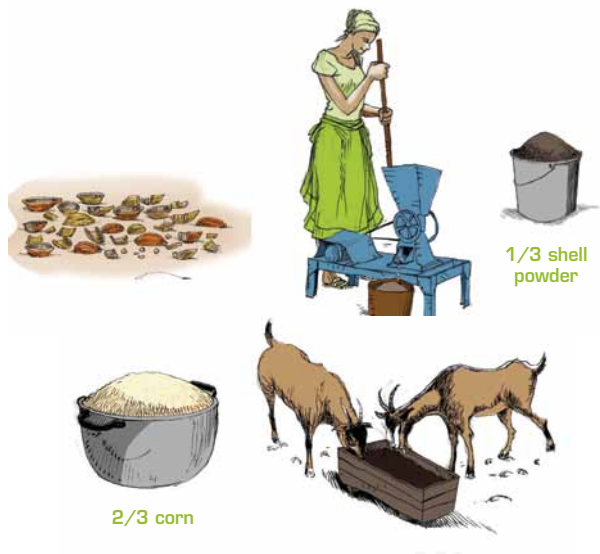
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## 7.2 Livestock feed

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- Dry the empty shells in the sun
- Grind them with a mill or a mortar and pestle to obtain a fine powder
- Mix the powder with corn flour at a ratio of  $\frac{1}{3}$  powder to  $\frac{2}{3}$  corn flour.

The feed produced can be enriched with mineral salts and vitamins.



**For animal feed, this flour can replace one third of the amount of corn.**



# 8

## COCOA PROCESSING METHODS

**Apart from chocolate, other products such as butter and beverages can be obtained from cocoa beans.**

### 8.1 Cocoa juice

Wash the harvested pods, then open them with sticks without sharp edges in order to collect the seeds without damaging them.

Put the beans in clean containers with small holes (e.g. sieves or rattan baskets). Place a cooking pot under the containers to receive the cocoa juice. To facilitate the extraction of the juice, stir the beans occasionally. After 24 hours, collect the juice. Approximately 1 litre of cocoa juice can be obtained from 35 kg of fresh beans.

Once the liquid has been collected, the beans can then begin the fermentation process.







This cocoa juice can be consumed fresh as a non-alcoholic beverage or fermented to obtain alcoholic drinks.

### 8.2 Pure cocoa natural mass or paste

There are two types of cocoa mass: natural mass and alkaline mass. Water is added during roasting of the natural mass, while an alkaline solution



(potassium carbonate) is added for the alkaline mass. The process described below is that for natural cocoa mass.

	<p><b>Sorting</b></p> <p>To remove any impurities from the cocoa beans, they must be sorted. The sorting is intended to remove all plant debris, pebbles, particles, as well as beans that are mouldy, moth-damaged or smoked, as these contribute to giving the cocoa butter an unpleasant taste and odour.</p>
	<p><b>Shelling or crushing</b></p> <p>The sorted beans are crushed, then the shells are removed by fans and only the seed (pure core) is retained. The separation of the shells and the seeds must be optimal, as the more pieces of shell there are in the seed, the more difficult the grinding process will be.</p>
	<p><b>Roasting</b></p> <p>The seeds obtained are roasted, i.e. their surface is heated to reduce the rate of humidity, eliminate the acidity formed during fermentation, facilitate shelling and crushing and enable the savours ("chocolate" flavour and aroma) to develop. The roasting process, which also sterilises the beans, is carried out at 98 - 120 °C for 90 - 95 minutes.</p>
	<p><b>Grinding</b></p> <p>The roasted seeds are ground using a ball mill crusher or a grinding machine to obtain a cocoa mass or paste used to make cocoa butter or chocolate. 100 kg quantity of cocoa beans produces 80 kg of cocoa paste.</p>

## **Semi-industrial process**



The key steps of cocoa processing are outlined in the following chart:





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## 8.3 Cocoa butter and powder

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The pure cocoa paste obtained is pressed to extract cocoa butter and cocoa cakes. 1 kg of cocoa paste produces on average 46 g of butter and 54 g of cake. The butter obtained is filtered, centrifuged and deodorised by steam distillation. The cocoa butter is used to produce chocolate or cosmetics.

### **Small cocoa butter press**



The cocoa cake obtained on completion of pressing is crushed and ground to make cocoa powder. This powder is tempered and stabilised between 18 and 20 °C. The cocoa powder is used to produce chocolate, pastries, milk-based drinks or cosmetics.

### **Cocoa powder**

#### SMALL-SCALE PRODUCTION OF COCOA BUTTER



##### **Ingredients**

- 10 litres of water (7.5 + 2.5 l)
- 5 kg of good quality dried cocoa beans

##### **Equipment**

- A gas stove or an improved oven (as heat source)
- A mill grinder
- An aluminium pan or bowl
- A transparent sheet of plastic
- A wooden or stainless steel spatula
- A 10-litre stainless steel cooking pot or casserole dish
- A 15-litre plastic bucket
- A glass



## PREPARATION

- Sort the beans and remove any mouldy or damaged beans and any foreign bodies (pebbles, debris, particles).
- Place the pan on the heat and pour a quantity of beans into it in proportion to the size of the pan so that each bean is in contact with the pan. Grill the beans for about 10 minutes on a very low flame. If the heat is too high, the beans will burn (which will spoil the aroma of the butter) or release butter (which will reduce the amount of butter obtained when the cooking is completed). The beans are considered to be well-roasted when the shell crumbles easily.
- Spread the roasted beans on the plastic sheet, shell them by hand then winnow them. Seeds and bean shells are obtained.



- Grind the seeds in a mill, not with a grindstone, so that the cocoa paste obtained is soft.
- Cook the paste in warm water for about 1 hr - 1 hr 20 mins. The cooking is done in two stages:

>>> in the first stage, put the paste (5 kg of beans) into 7.5 litres of boiling water. Always stir the mixture in the same direction and bring it to the boil on a medium heat (to bring out the oil). When the mixture begins to thicken, reduce the heat. Do not allow the paste to burn or stick to the base of the pot to avoid having an unpleasant odour. The oil will gradually rise to the surface after 40 - 50 minutes. After boiling, collect the floating oil

>>> next add 2.5 litres of boiling water to the pot containing the cocoa mass, stir it in the same direction and bring it to the boil for approximately 20 - 30 minutes.

- Use a beaker to collect the oil that rises to the surface of the pot. The oil is brought to the boil in another pot to remove the water in it. The oil can be filtered and bottled.



- Keep the cooking pot away from the heat and, after 48 hours, collect the layer of solid butter that will have formed on the surface. Melt it and bottle it.
- It should be noted that the oil obtained solidifies very quickly at room temperature, so once it has been filtered it must be bottled immediately. Handled skilfully, 5 kg of beans produce 1 kg of cocoa butter. After extracting the cocoa butter, the cake obtained can be used to make chocolate or live-stock feed. It could also be turned into cocoa powder for better preservation.



## 8.4 Chocolate

Chocolate is made from 4 principal ingredients: cocoa paste, cocoa butter, sugar and powdered milk (if required). Soy lecithin as an emulsifier (0 – 0.5 %) and some vanilla for flavour can be added, as well as a preservative (citric acid) to extend the life of the product.

### SMALL-SCALE PRODUCTION OF MILK CHOCOLATE BARS

#### Ingredients: For 1 kg of chocolate

- 400 g of sugar
- 230 ml of cocoa butter
- 220 ml liquid cow's milk
- 150 g of cocoa cake
- 1 teaspoon of juice from a small lemon
- 1/2 teaspoon of cooking salt
- Flavour (vanilla or nutmeg)

#### Equipment:

- A gas stove or an improved oven (as heat source)
- A cooking pot
- A spatula
- A grindstone
- Moulds (ice cube trays)



## PREPARATION

- Grind the sugar with a grindstone to make it very fine.
- Heat the cooking pot on a very low heat and put the cocoa cakes in.
- Add the cocoa butter (liquid) and stir for 10 - 15 minutes until the mixture is homogenous. If necessary, remove the pot from the heat occasionally, to make sure that the paste does not burn.
- Add the milk in small quantities while stirring gently for 5 mins.
- Add the finely ground sugar in small quantities while stirring for 5 - 10 mins.
- Add the salt, vanilla and lemon juice and continue to stir the mixture for 5 mins.
- Remove the pot from the heat and pour the mix into an ice cube tray to set.
- Place the ice cube tray in a refrigerator (not a freezer) and leave to solidify for 8 - 10 hrs.
- Keep your chocolate in the refrigerator. The citric acid will enable you to preserve it for several months.
- Tip: To prevent the chocolate from burning, bring a large cooking pot of water to the boil and then place a smaller stainless steel pan into the pot (bain-marie). The different ingredients are placed in the smaller pan, not in the cooking pot of water.





## SMALL-SCALE PRODUCTION OF DARK CHOCOLATE BARS

### Ingredients: For 1 kg of chocolate

- 450 g of sugar
- 250 ml of cocoa butter
- 300 g of cocoa cake
- 1 teaspoon of lemon juice
- 1/2 teaspoon of cooking salt
- Flavour (vanilla or nutmeg)

Follow the same operating method as for milk chocolate.



## SMALL-SCALE PRODUCTION OF CHOCOLATE SPREAD (WITH OR WITHOUT NUTS)

### Ingredients: For 1 kg of chocolate spread

- 400 g of sugar
- 250 ml of cocoa butter
- 200 ml liquid cow's milk
- 150 g of cocoa cake
- 100 g of roasted and finely ground peanuts (optional)
- 1 teaspoon of juice from a small lemon
- 1/2 teaspoon of cooking salt
- Flavour (vanilla or nutmeg)

Follow the same operating method as for milk chocolate. Incorporate the hazelnuts after adding the milk.







- Keep chocolate products at a temperature of 12 - 20 °C in a well-aerated place.



- Keep chocolate away from strong odours (cheese, fish, meat, lemons, etc.).



- Protect chocolate from air, sunlight and rain by keeping it covered.



# 9

## ADDITIONAL INFORMATION

### 9.1 Economic information

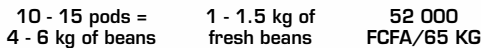
The dried beans are placed in 65-kg jute bags and then sold. On average, 10 - 15 pods are harvested per plant, i.e. 4 - 6 kg, giving 1 - 1.5 kg of fresh beans which, after 7 % drying, represent approximately 0.5 kg of marketable dried beans. Therefore, for 1,000 healthy and productive trees per hectare, it is possible to obtain a yield of 300 - 750 kg/ha. Sold at 800 FCFA/kg, this generates a gross income of 400,000 - 600,000 FCFA/ha. After subtracting expenses (55 %), there is a net profit of FCFA 225,000 (€ 343) per hectare.

Below is the operating account over 6 years of a farmer practicing an agro-forestry system (cocoa, banana and fruit trees) over an area of 2 hectares.

PRODUCTION COST: 2 HECTARES						
Description	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Site development	200 000					
Purchase of banana plants	222 200					
Purchase of cocoa plants	333 300					
Purchase of fruit tree plants	207 000					
Cutting posts	69 000					
Staking (banana + cocoa + fruit trees)	100 000					
Transplanting (banana + cocoa + fruit trees)	460 000					
Phytosanitary treatment	100 000	100 000	100 000	300 000	300 000	300 000
Maintenance	200 000	200 000	300 000	600 000	600 000	600 000
<b>Annual cost</b>	<b>1 891 500</b>	<b>300 000</b>	<b>400 000</b>	<b>900 000</b>	<b>900 000</b>	<b>900 000</b>



Income from production: 2 hectares						
Description	Année 1	Année 2	Année 3	Année 4	Année 5	Année 6
Sale of brunches of bananas		2 000 000	2 000 000	2 000 000		
Sale of banana waste		200 000	200 000	200 000		
Sale of cocoa				480 000	640 000	800 000
Sale of fruits (from fruit trees)					690 000	1 380 000
Annual income	-	2 200 000	2 200 000	2 680 000	1 330 000	2 180 000
Annual margin	1 891 500	1 900 000	1 800 000	1 780 000	430 000	1 280 000
Consolidated margin		8 500	1 808 500	3 588 500	4 018 500	5 298 500



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## 9.2 Useful contacts

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### ■ **Togolese Institute for Agronomic Research (ITRA)**

P.O. Box 1163 Lomé (Togo)

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### ■ **National Centre for Agronomic Research (CNRA) - Côte d'Ivoire**

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Fax: (+225) 22 48 96 11

www.cnra.ci

### ■ **Society for the Development of Cocoa (SODECAO)**

P.O. Box 1651 Yaoundé (Cameroon)

Tel.: (+237) 22 30 45 44/22 30 35 08

Fax: (+237) 22 30 33 95

Email: contact@sodecao.cm

www.sodecao.cm

### ■ **Sic Cacaos - Cameroon**

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Cameroon Cocoa Horizons

Tel.: (+237) 33 40 88 10/ (+237) 33 40 37 95

Email: siccacaos@barry-callebaut.com

www.barry-callebaut.com/csr/qualitypartnerprogram

### ■ **International Cooperation Centre in Agronomic Research for Development (CIRAD)**

CIRAD Regional Directorate for Central Africa

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### ■ **World Cocoa Foundation**

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Rue L 54, Abidjan (Côte d'Ivoire)

Tel.: (+225) 22 52 37 32

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# cocoa

## production and processing

Pro-Agro is a collection of practical, illustrated guides that are jointly published by CTA and ISF Cameroun. They are an ideal source of information for farmers, rural communities and extension workers in tropical and subtropical regions.

This practical guide sets out the procedure for the production and processing of cocoa as well as a recommended technical schedule for the production of cocoa plants. It stresses the importance of phytosanitary protection and post-harvest operations. It also provides useful advice and economic information on this agricultural sector.

- **The Technical Centre for Agricultural and Rural Cooperation (CTA)** is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU). Its mission is to advance food and nutritional security, increase prosperity and encourage sound natural resource management in ACP countries. It provides access to information and knowledge, facilitates policy dialogue and strengthens the capacity of agricultural and rural development institutions and communities. CTA operates under the framework of the Cotonou Agreement and is funded by the EU.

- **Engineers without Borders (ISF)** is a network of professionals in more than 52 countries to promote human development through improved access to scientific and technical knowledge. In Cameroon, ISF works together with local people to improve their livelihoods and strengthen their technical capacity by sharing and diffusing information adapted to their needs.

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