

# **Agriculture in Vanuatu**

## **Cocoa**



### **Notes for Teachers**

#### **Year 9**

**Ministry of Education  
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# 1. Introduction

## Uses

Cocoa is grown as a **cash crop**.

Its seeds, called cocoa beans, are sold for processing to make **chocolate powder**.

Chocolate powder is used to make things like:

- chocolate drinks e.g. Milo
- chocolate sweets, cakes, and biscuits.

## World distribution

Cocoa was first found in the tropical rain forests of South America.

It is now grown commercially in most tropical areas of the world, including the South Pacific.

The main cocoa producing area in the world is West Africa, e.g. Ivory Coast, Ghana and Nigeria. Quite a lot is also produced in Central and South America, e.g. Brazil and Mexico.

## Vanuatu distribution

The Vanuatu climate, especially in the northern islands, is favourable for cocoa production, (see section 6).

Most of the cocoa is produced on Malakula with the rest coming mainly from Santo, Malo and Ambae (see Table 1).

During 1996 the total cocoa export value was second only to copra (see Table 2).

Most of the cocoa is produced by smallholders (see Table 3). This situation has been encouraged by the Government in order to give smallholders an alternative source of income besides copra.

The potential exists for both, increased production and improved quality. The work of the CIRAD (Centre International de Recherches Agronomiques pour le Développement) on Santo is looking at new varieties and growing techniques.

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**Table 1 Cocoa Production between 1993 to 1996**

<b>ISLAND</b>	<b>TONNES</b>			
	1993	1994	1995	1993
Banks/Torres	4	0	1	1
Santo/Malo	471	287	463	237
Ambae/Maewo	153	96	147	67
Pentecost	22	10	14	4
Malakula	1456	808	1148	621
Ambrym	6	1	6	2
Paama	1	0	0	0
Epi	3	4	6	4
Shepherds	0	0	0	0
Efate	1	0	1	1
Tafea	0	0	0	0
<b>TOTAL</b>	<b>2117</b>	<b>1206</b>	<b>1786</b>	<b>937</b>

**Table 2 Vanuatu Exports (VT millions)**

	<b>Copra</b>	<b>Cocoa</b>	<b>Beef/Veal</b>	<b>Timber</b>	<b>Other</b>	<b>Total</b>
1993	28013	13393	1619	6612	2740	<b>40377</b>
1994	26441	1706	1612	4126	3004	<b>36889</b>
1995	28520	111035	1502	3257	3758	<b>38072</b>
1996	30026	1247	1584	7259	2913	<b>43023</b>

N.B. Students should not be expected to learn the figures in Tables 1, 2 or 3.

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## 2. The Cocoa Tree

A young cocoa tree grows about 1 to 2 metres high and then forms 3 to 5 branches. These are called **fan branches**.

The place at the top of the trunk where fan branches form is called the **lorquette**.

Shoots often form on the trunk, below the lorquette. These are called **chupons**.

Flowers form in groups on the trunk and main fan branches.

Some flowers will be pollinated and fertilized to form fruits called **pods**.

A deep tap root holds the tree firm in the soil.

Shallow, lateral roots absorb water and nutrients from the soil. These are sometimes called **feeder roots** (see figure 1).



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### 3. Cocoa Flowers

Cocoa flowers grow in groups from the bark of the trunk and main fan branches.

These flower groups grow out from small bumps on the bark called **cushions** (see figure 2).

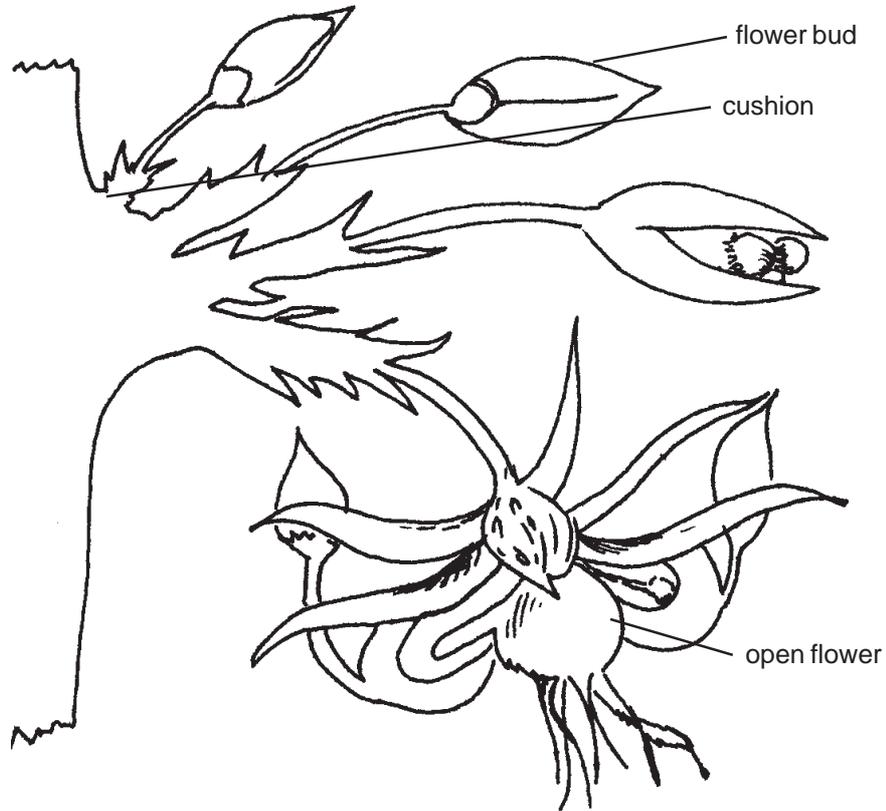
#### Flower Parts

(See figure 3)

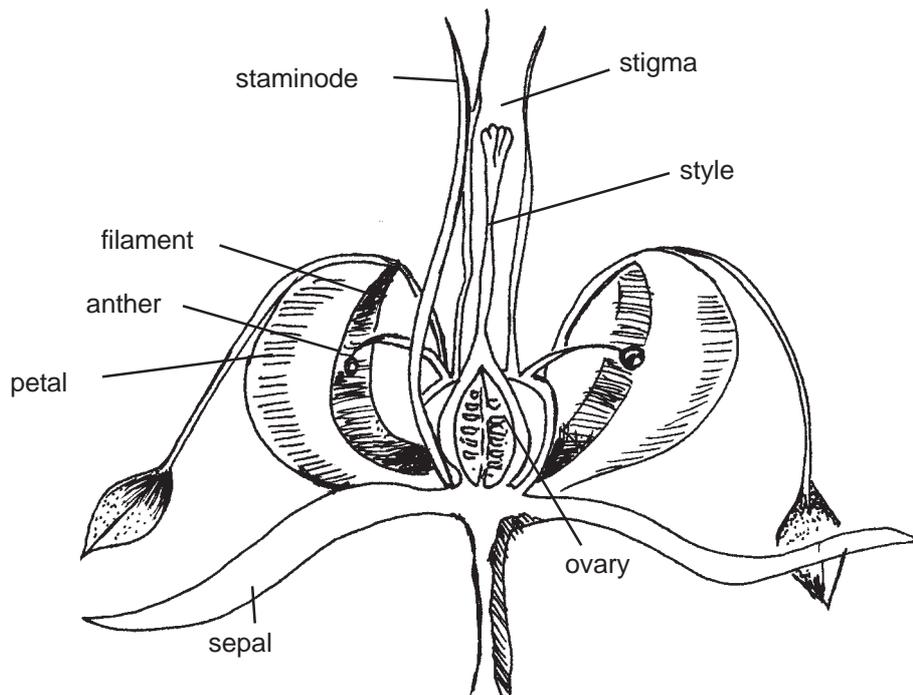
Each individual flower contains:

- long, pink **sepals**.
- yellow-white (sometimes pinkish) **petals**. These are an unusual shape, each forming a hollow, sac-like pouch.
- **stamens** - their **filaments** bend over so that the **anthers** are found inside the petal pouches.
- **staminodes** - These are **sterile**, which means they *do not* produce pollen.
- **style** - At the top, this splits to form 5 **stigmas**.

**Figure 2**                      **A group of cocoa flowers**



**Figure 3**                      **An open cocoa flower**



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## Pollination and fruit formation

**Pollination** of cocoa flowers is by **insects**.

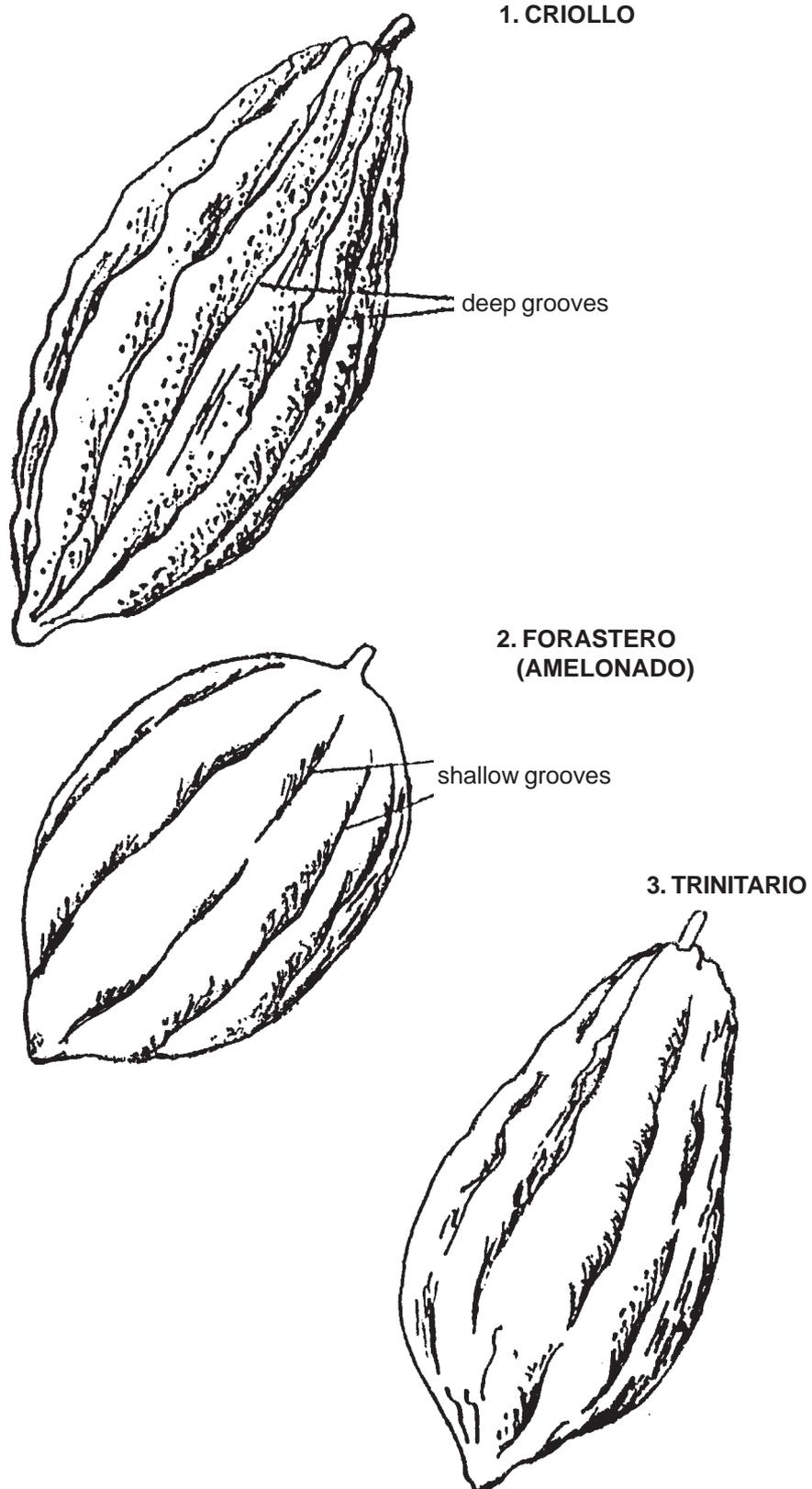
After pollination and fertilization, few of the flowers ever form fruit (5%). Many fertilized flowers just drop off the tree, this is called **cherelle wilt**.

Even when a flower turns into a fruit, young fruit often shrivel up and drop off the tree.

Once a young fruit is 3 months old, it will usually stay on the tree and develop properly.

It takes about 6 months from flower fertilization to fruit maturity.

**Figure 4**      **Types of cocoa pod**



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## 4. Cocoa Pods

**Pod** is the name we give to the cocoa fruit.

A cocoa tree will first start to bear pods when it is about 4 to 5 years old.

Pods are attached to the cushion of the trunk, or branch, by a strong stalk.

Pods can be different shapes and colours depending on the type of cocoa (see figure 4).

### Types of cocoa

#### 1. Criollo

This type is **not** common in Vanuatu. Its pods are:

- long, with a pointed end
- deeply grooved
- very rough, and have small bumps on the surface
- a reddish colour.

#### 2. Forastero (Amelonado)

The most common kind of cocoa in Vanuatu is a variety of this type, called **amelondo**. Its pods are:

- short, without a pointed end
- have only very shallow grooves
- smooth on the surface, without any bumps
- green in colour, changing to yellow when ripe.

#### 3. Trinitario

There is not much of this kind in Vanuatu. It is formed by crossing criollos and forasteros. Its pods have characteristics which are between the other two kinds.

N.B. The wall of the pod is sometimes called the **husk**.

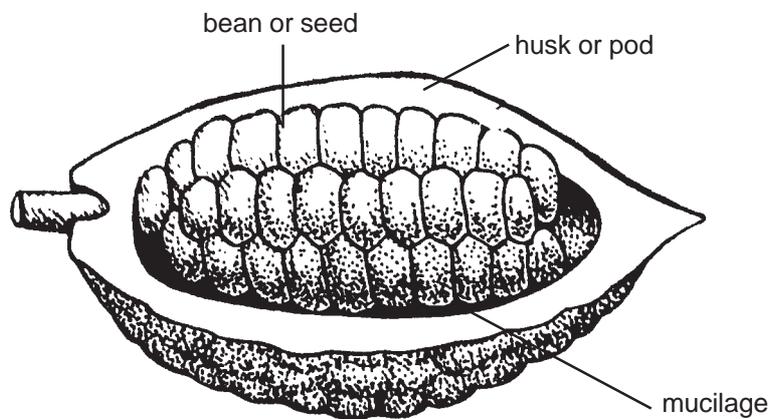
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## 5. Cocoa Seeds

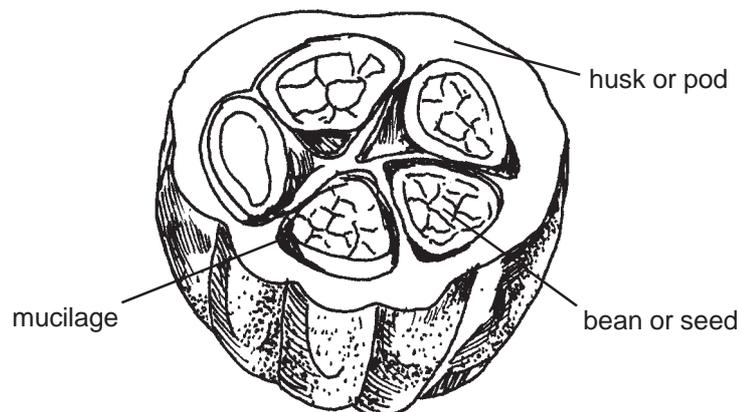
The cocoa pod contains many seeds, which are often called **beans**.

The seeds are surrounded by a sweet, sticky, white substance called **mucilage** (see figure 5 and 6).

**Figure 5** Cocoa pod cut along its length



**Figure 6** Cocoa pod cut in cross section



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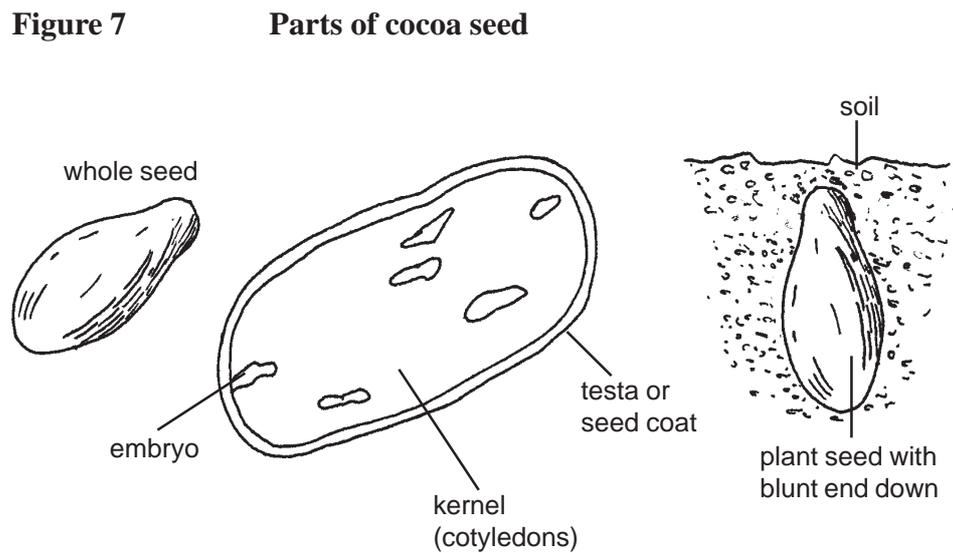
When a seed is removed from the pod a small mark or **scar** is left on the outside.

This scar is very important because when a seed is planted, this scar must be placed downwards in the soil. (See section 9 and 11, also see figure 7.)

### Parts of a Cocoa Seed

(See figure 7)

- i. **Testa**, which is the tough seed coat
- ii. **Embryo**, which grows into the new plant
- iii. **Cotyledons**, which store food. There are 2 cotyledons (cocoa being a **dicot**) and they are sometimes called the **kernel** of the seed.



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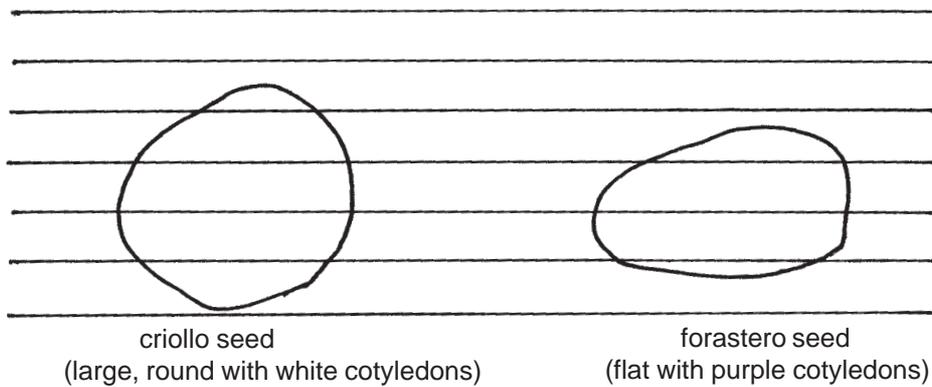
## Seed shape and colour

(See figure 8)

The shape and colour of seed depends on the kind of cocoa:

- i. **Criollo:** large, round seed with white cotyledons
- ii. **Forastero:** flat seed, with purple cotyledons (**Amelonado**)
- iii. **Trinitario:** seed shape is between criollo and forastero, with light pink, or violet cotyledons.

**Figure 8** Seed of criollo and forastero (amelondado)



Note: Trinitario seeds are between the shape of the two above.

Later, after harvest, the beans are removed from the pod, separated from the mucilage during fermentation, dried and then sold for processing.

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## 6. Growing Conditions for Cocoa

To grow well, cocoa needs the following conditions:

- i. **SOIL** which is:
  - deep (more than 2m)
  - rich in plant nutrients
  - well drained
- ii. **CLIMATE** which has:
  - high humidity
  - plenty of rainfall (but not too much, which can cause disease problems), about 1,250 mm to 2,800 mm.
  - high, regular temperatures

**N.B.** South of Epi, temperatures in Vanuatu are not regular enough for good cocoa production.

- iii. Protection from strong winds
- iv. Protection from direct sunlight (only during the early stages of establishment)
- v. Cocoa should not be grown too close to the sea, because it is susceptible to damage by salt spray.

So, in Vanuatu, area of islands north of Epi, which have adequate rainfall and deep fertile loam soil, are best suited to growing cocoa.

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## 7. Provision of Shade

Having selected a suitable area for cocoa, based on the information given in the previous chapter, we must first provide shade trees for our cocoa. Shade trees are necessary because young cocoa plants **do not grow well in direct sunlight**.

We can divide the different shade trees into two main groups:

1. **Temporary**
2. **Permanent**

### 1. Temporary shade trees

These are usually established prior to planting cocoa, and then **removed as the cocoa develops into maturity**.

Once cocoa plants develop into maturity their leaf canopies provide shade for each other; this is called **autoshading**. So temporary shade is removed as the cocoa plants begin to autoshade.

Here are some examples of plants that can be used to provide temporary shade, together with some advantages and disadvantages for each:

- i. **Pigeon pea:** planted 3 to 4 months before the cocoa, using seed.

Advantages:

- seeds are high in protein, making useful human or animal feed
- it is a legume, thus enriching the soil with nitrate

Disadvantages :

- not cyclone resistant
- shed seed can cause weed problems later

- ii. **Banana:** planted 6 months before the cocoa using suckers (see notes in Vegetable Growing)

Advantages:

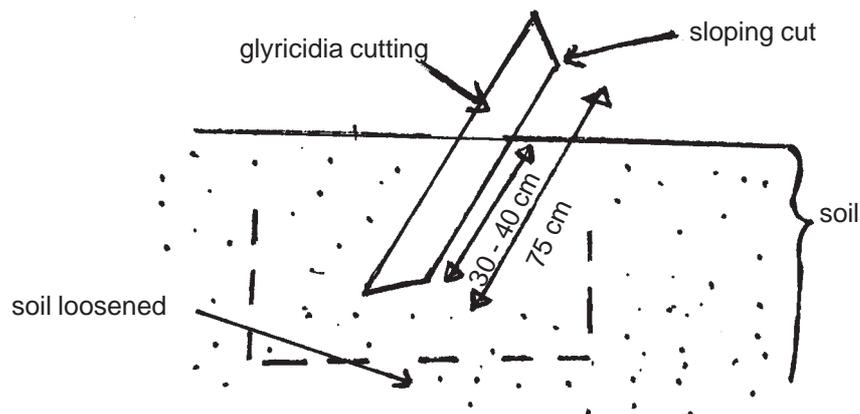
- provide good food
- planting material widely available

Disadvantages:

- not very cyclone resistant
- not a legume
- need a lot of thinning

- iii. **Glyricidia:** planted 6 months before cocoa using cuttings (see figure 9).

**Figure 9 Glyricidia cutting**



**Advantages:**

- fast growing
- it is a legume
- provides a good shade canopy

**Disadvantages :**

- not cyclone resistant
- no food provided

- iv. **Blue Water or Rosewood:** Planted 6 months before cocoa using cuttings (as for glyricidia). (**Bislama: Nananarr**)

- Advantages**
- cyclone resistant
  - it is a legume

- Disadvantages**
- not widely available
  - no food provided

A farmer would have to decide on the best shade plants to use, based on the availability of planting material, and the advantages and disadvantages given above.

## Planting arrangements for temporary shade

Before planting, the area should be cleared of heavy bush.

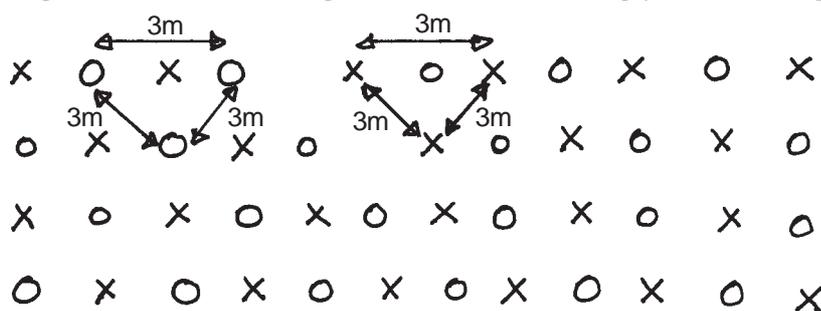
The positions for planting cocoa and shade trees should be marked out, using a rope and marking sticks. **Spacing of cocoa** = 3m x 3m in a **triangular pattern**.

Shade trees should be placed evenly around the cocoa plants, and then gradually remove as the cocoa develops.

As we have seen, many different kinds of trees, or combinations of them, may be used for temporary shading e.g. banana plants alone, or banana plus pigeon pea.

Figure 10 shows an example of how cocoa could be arranged with glyricidia and pigeon pea providing shade.

**Figure 10** Arrangement of cocoa with glyricidia and pigeon pea



<b>KEY:</b>	X	=	Cocoa
	O	=	Glyricidia
	o	=	Pigeon pea

## Thinning

Thinning is a gradual process.

Using the example in figure 10:

- pigeon peas should be removed 6 months after cocoa planting
- glyricidia is planted at 3m x 3m triangular spacing then
- between 1 to 3 years reduced to 6m x 6m triangular spacing
- between 3 to 6 years reduced to 12m x 12m triangular spacing

Finally, at 6 years all the remaining glyricidia can be removed as the cocoa plants should have reached the point of **autoshading**.

## 2. Permanent shade trees

Permanent shade trees grow together with the cocoa and are **not removed**. The most common permanent shade used in Vanuatu is **coconut**. Once coconut trees reach 5 to 6 years of age they provide enough shade for cocoa.

### Effect on income

The yield and income of cocoa per hectare, where it is grown under coconuts, will be lower than for where cocoa is grown alone (once the temporary shade has been removed). However, where cocoa is grown under coconuts its income supplements the farmer's income from copra, so that the farmer's **total** income per hectare can be similar, or even greater than where cocoa is grown alone.

Growing 2 or more crops on the same piece of land at the same time is called **mixed cropping**, or **intercropping**. Mixed cropping makes farmers less dependent on any one particular crop.

(N.B. Mixed cropping is discussed in more detail in the unit for Management of the Whole Farm.)

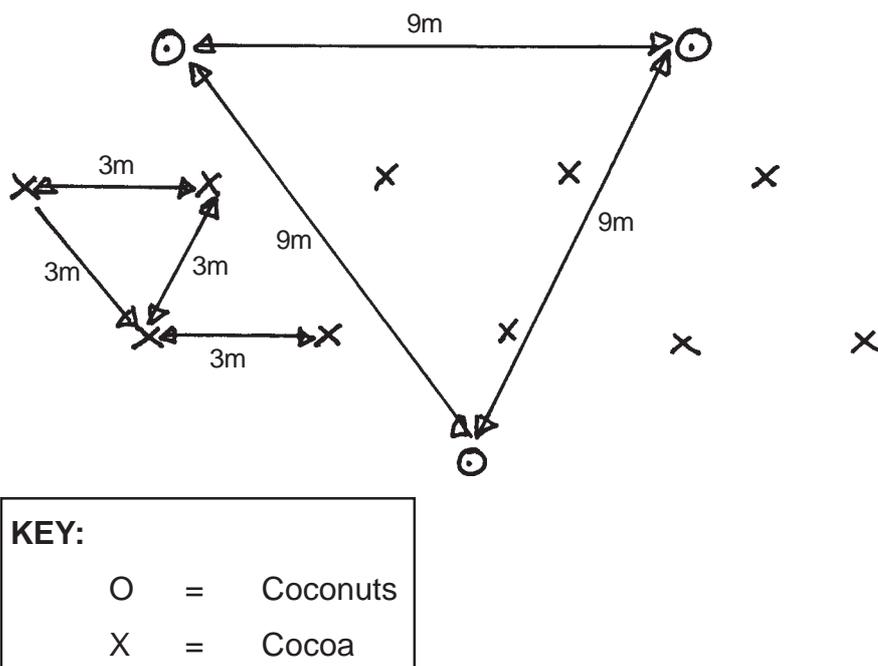
### Planting arrangements for cocoa and coconuts

Coconuts are arranged in 9m x 9m triangular spacing.

Cocoa is arranged in 3m x 3m triangular spacing.

Figure 11 shows how the two crops can be arranged together.

**Figure 11** Arrangement of cocoa with coconuts



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## 8. Which kind of cocoa to grow

As seen in sections four and five, there are three kinds of cocoa, which have different pod and seed characteristics. They also have different characteristics for yielding ability and quality:

### a. Criollo

This kind of cocoa has very good quality characteristics **but** it is susceptible to disease and does not give high yields.

Therefore criollos cocoa is **not recommended** for production in Vanuatu.

### b. Forastero (Amelonado)

This kind of cocoa is more hardy, vigorous and shade tolerant than criollo.

Its quality is not as good as criollos, but it gives larger yields.

The most common variety of forasteros is called **amelonado**. About 80% of the world's cocoa is produced from amelonado.

N.B. **Amelonado** is the recommended cocoa variety for production in Vanuatu.

### c. Trinitario

This is a **hybrid**. It is formed by cross pollinating criollos and forasteros.

It has to be grown from cuttings and not seeds, so farmers are unable to save seeds for seedling production.

Because it is a hybrid, it combines the quality of criollos with the hardiness and yielding ability of forasteros.

At the moment it is not recommended for production in Vanuatu, but researchers at C.I.R.A.D. feel that it could become important in the future.

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## 9. Raising Cocoa Seedlings

When a farmer wishes to start a cocoa project he can purchase seedlings from his local Agriculture Field Station.

Once his project is established, should he wish to expand, he could save some of his own seeds and raise seedlings for planting.

It is important to carefully select seeds, to ensure that they produce healthy, high yielding cocoa trees.

### a. Selection of pods

- i. Only select pods from trees which are healthy, high yielding, and have a good shape.
- ii. Only select large, ripe, healthy pods. A ripe pod of amelonado will be complete yellow and will rattle when it is shaken.
- iii. Break open pods by hitting them firmly with a stick. (Using a bushknife can damage the seeds inside.)

Pods should not be kept for more than a week before seeds are selected and planted. If kept for longer, the seed embryo can die.

### b. Selection of Seed

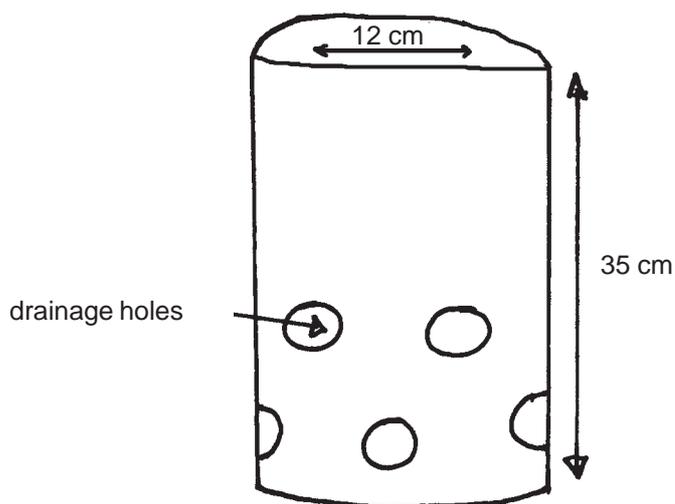
- i. Only select big, healthy seeds from the middle of the pods.
- ii. Try to remove the mucilage which surrounds the seed, this will speed-up the germination process.

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**c. Sowing The Seed**

Seeds are sown into poly bags, which should be 12 cms diameter and 35 cms deep, with holes for drainage (see figure 12).

**Figure 12 Poly bag for sowing cocoa seed**

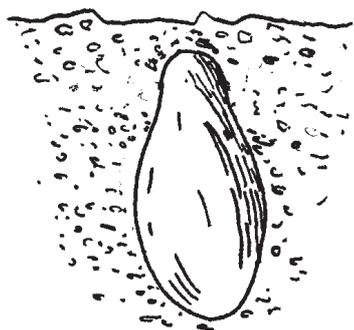


These bags can be purchased from the Local Agriculture Extension Officer (costing about VT 2 each).

Fill the bags with good quality **topsoil**.

Carefully sow the seeds 1 to 1.5 cms deep with **seed scar pointing downwards** (see figure 13).

**Figure 13 Correct sowing of cocoa seeds**



It is important that the seed scar points downwards to ensure germination.

If the seed scar cannot be located then it is possible, as an alternative, to sow the seed flat.

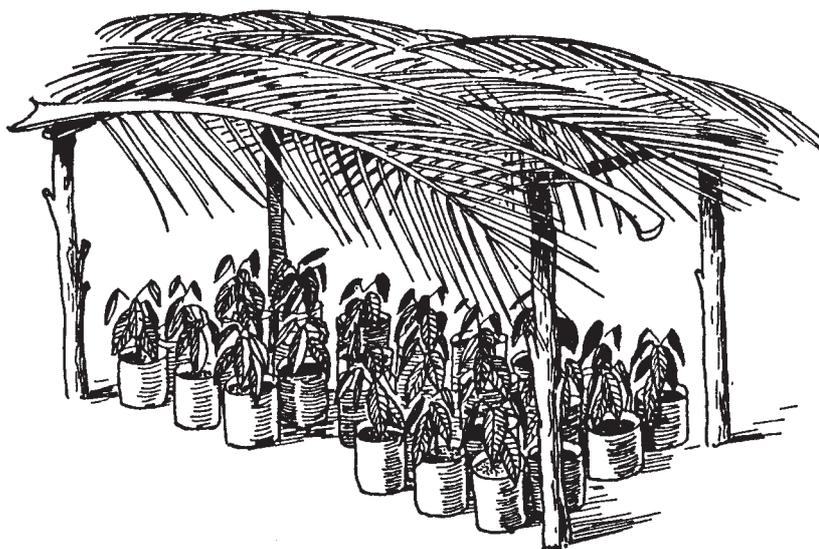
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#### d. After Sowing

After sowing the contents of the bag seedlings should be:

- i. kept well watered
- ii. provided with shade e.g.
  - \* place them under shade trees or
  - \* place them under a strong frame covered with shading leaves (see figure 14).

**Figure 14**                      **Shading of cocoa seedlings**



#### Raising of cuttings

For the propagation of trinitario cocoa, it is necessary to use cuttings (see Section Eight).

Cuttings should be taken from **chupons** and **not** fan branches.

Chupon cuttings produce trees with a better canopy shape and root structure than fan branch cuttings.

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## 10. Planting of Cocoa Seedlings

Cocoa seedlings should be ready for planting-out at about 5 to 6 months after sowing. They should be about 30 cms tall.

The positions for planting should be marked out using an arrangement such as those described in Section 7.

N.B. Cocoa is planted at 3m x 3m triangular spacing.

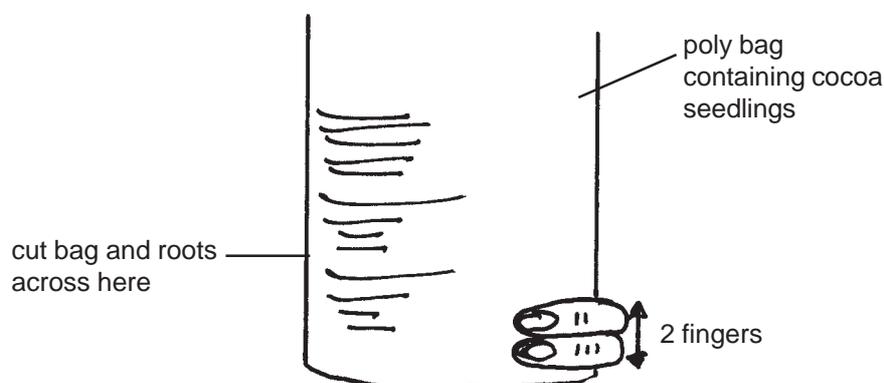
Only strong, healthy seedlings should be selected for planting.

Before planting, a circular area of about 1 m diameter should be cleared around each planting position.

### Planting technique

1. A hole, big enough to take a seedling, should be dug at the planting place.
2. The poly bag **plus contents** (i.e. roots) should be cut across the bottom at a distance of 2 fingers from the base of the bag (see figure 15).

**Figure 15**                      **The position of where to cut the poly bag**



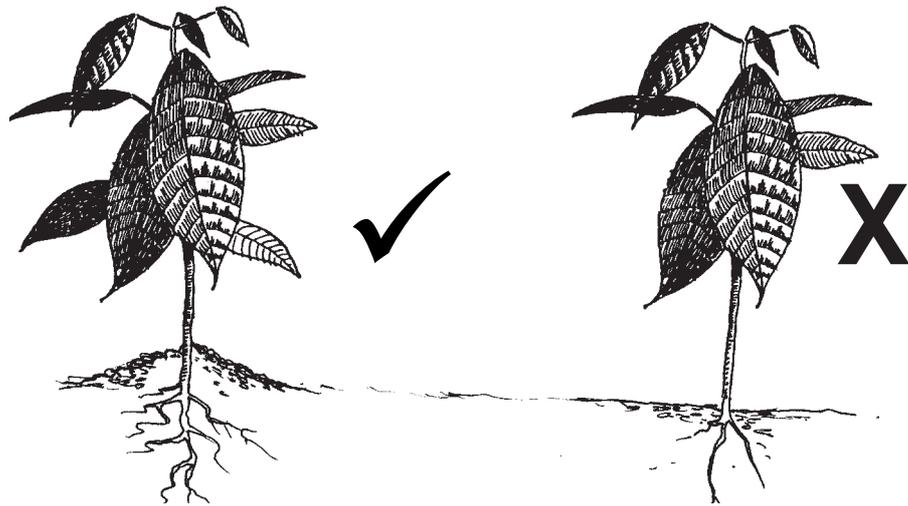
Cutting across removes the tangled root mass at the bottom of the bag, and gives stronger tap root growth in the planted seedling.

3. Place the cocoa plant inside the dug hole, after carefully removing the rest of the poly bag.
4. Fill around the seedling with good topsoil.
5. Firm the soil carefully around the roots. Do not leave a depression around the plant, otherwise water may collect, and the seedling could be killed (see figure 16 on page 27).

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**Figure 16**

**The correct way to plant a cocoa seedling**



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## 11. Sowing Cocoa Seeds at Stake

This is an alternative method for establishing cocoa.

Seeds are sown **direct into the plantation** area, as opposed to sowing in a nursery first.

### Advantages

1. No nursery costs
2. No water required
3. Low labour requirement

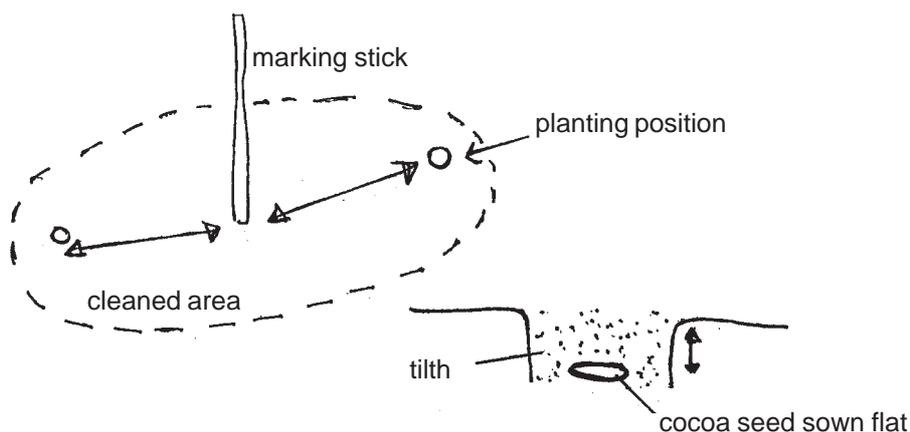
### Disadvantages

1. More seeds required
2. Seedling selection is harder
3. Maintenance of the whole area required immediately

### Sowing technique

1. The soil at the marking stick should be loosened with a fork.
2. Plant 2 seeds, about 10 cm each side of the stick, as shown in figure 17.
3. Sow seeds 1 to 2 cms deep, with the scar pointing down or flat (see figure 17).
4. After 2 months, remove the weakest seedling to leave 1 strong seedling at each place.

**Figure 17**                      **Marking stick position and depth of cocoa seeds shown at stake**



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## 12. Care of the Growing Cocoa

To ensure healthy, strong growth of cocoa, after planting, we must carry out the following tasks:

- i. Regular weeding
- ii. Regular brushing
- iii. Shade thinning
- iv. Pruning
- v. Mulching
- vi. Observation and control of pests and diseases.

### i. Weeding

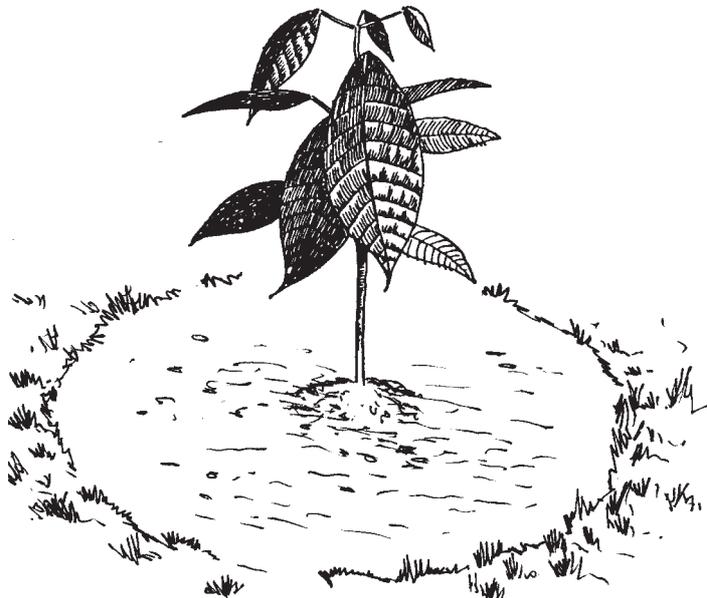
Weeding is important to reduce competition for water, nutrients and light.

It must be done as often as necessary from planting until the cocoa trees reach about 18 months.

Weeds should be removed from a circle around the cocoa plants. This is called **ring weeding**.

The circle should be 1 m in diameter (see figure 18).

**Figure 18**                      **Ring weeding cocoa seedlings**



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Care should be taken not to dig too deeply into the soil when weeding. This is to avoid damaging the shallow **feeder roots**.

It is possible to ring weed using a **herbicide** such as **gramaxone** but the operator must be careful not to spray the cocoa seedlings. This is expensive and only appropriate for larger plantations.

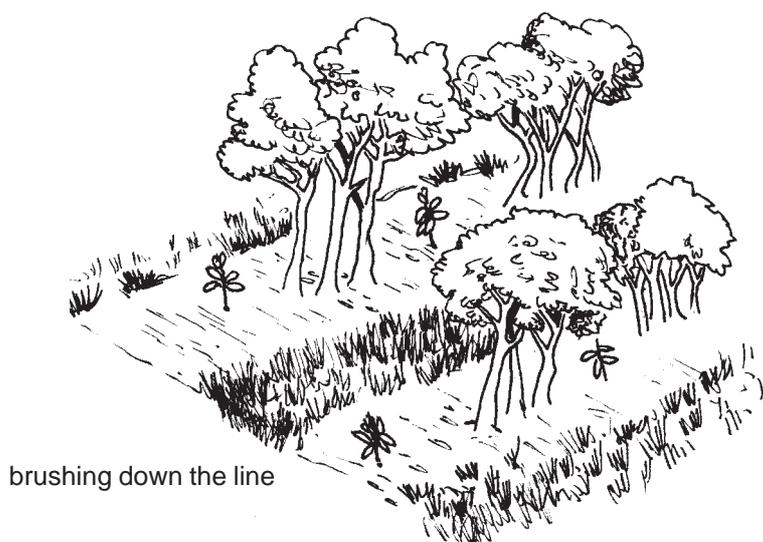
After 18 months the cocoa should have a good leaf canopy, which will help to keep the weeds down. Occasional weeding may still be required, as some weeds will continue to grow.

## ii. **Brushing**

This is when weeds are cut down along the line of cocoa trees. This is done to make it easy to get to the cocoa trees.

The ground between the rows should be brushed regularly in a 2m strip (see figure 19).

**Figure 19**                      **A brushed area of cocoa**



## iii. **Shade thinning**

It is important to remove temporary shade plants gradually, as the cocoa begins to grow.

This is important to allow maximum sunlight for photosynthesis.

Thinning of shade has already been discussed in section 7.

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#### iv. Pruning

This is the removal of unwanted branches from the cocoa tree.

The main reasons for pruning are:

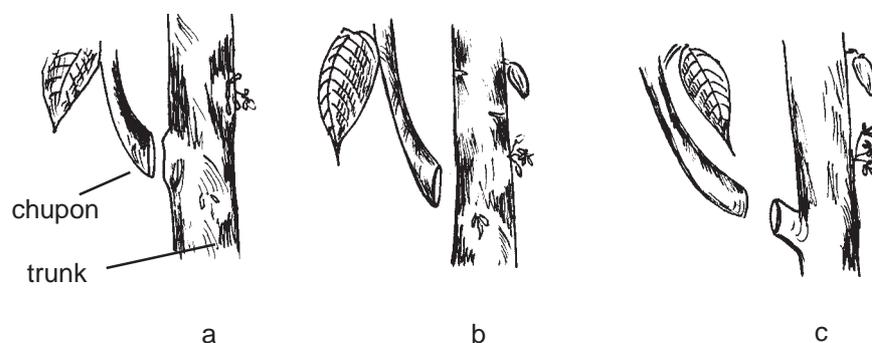
- a. To give strength to the growing cocoa tree.
- b. To help it to grow into the desired shape.

Branches that should be pruned are:

- a. All **chupons**
- b. All branches and dead wood that hang below the jorquette.

The diagram below show the correct way to remove chupons.

**Figure 20 Correct and incorrect ways to remove chupons**



- a = Correct, close to the main trunk, but without damage to the bark.
- b = Cut too close to the trunk, may lead to termite damage or disease entry at the wound.
- c = Cut too far from the trunk, may lead to more chupons growing back.

Pruning should be done using only clean, sharp knives and secateurs.

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## v. **Mulching**

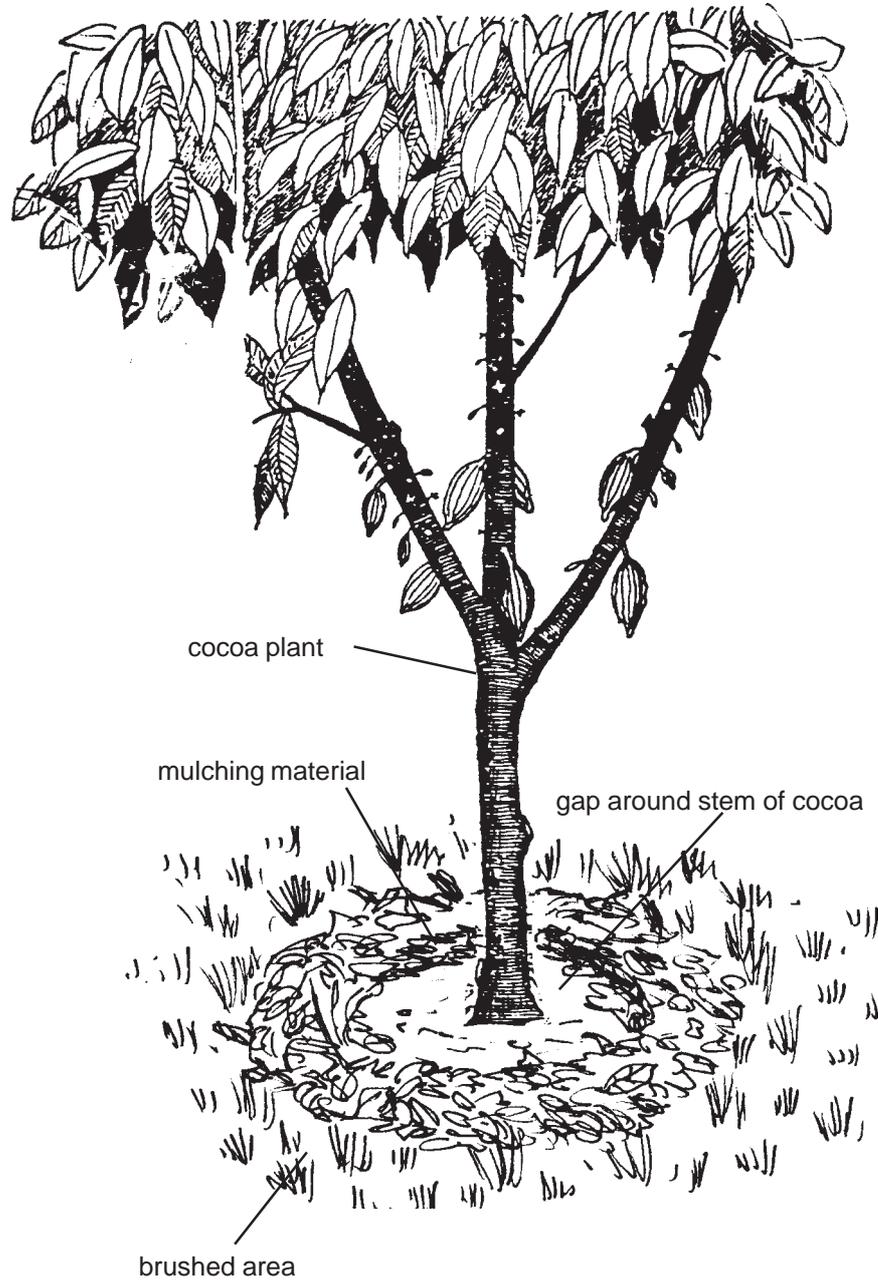
This is when we cover the soil around the base of the cocoa with dead weeds, grass etc.

The main reasons for mulching are:

- a. To help keep moisture in the soil
- b. To protect against soil erosion
- c. To prevent weed growth around the cocoa
- d. To supply humus to the soil which:
  - releases nutrients for the growing cocoa
  - helps maintain good soil structure
  - helps retain moisture in the soil.

Mulching material should be placed around the base of the cocoa, but a gap should be left close to the stem to help prevent possible pest or disease attack (see figure 21).

**Figure 21**      **Mulching of cocoa**



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## vi. Control of pests and diseases

### Pests

#### a. Rats

Easily the most serious pest of cocoa is the **rat**.

Rats climb up the trees and eat into the pods, destroying the cocoa beans.

The current estimate is the 30% of present cocoa production is lost due to rats.

Rats can be controlled by:

- regular brushing and cleaning of the plantation
- keeping snakes in the cocoa trees
- using rat bait (e.g. Warfarin) at the site and within the plantation.

#### b. Rose beetles

A pest of increasing importance is an insect called **rose beetle**.

Rose beetle attacks the cocoa at night eating holes in the plant leaves.

During the day it lives in the soil. It feeds on the edges of the plantation, moving in from the bush.

Rose beetle may be controlled by spraying an insecticide (e.g. **Ontec 8**) but this is costly.

### Diseases

#### a. Black pod

Currently the most serious cocoa disease is **black pod**.

It is caused by a fungus growing on the pod.

It can spread quickly especially during the wet season.

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The symptoms of Black pod disease are:

- small brown spots appear on the pods.
- these spots grow larger, and change to black covering the whole pod.
- diseased pods when opened smell *fishy* inside.

Black pod disease is controlled by:

- frequent harvesting and inspection of trees (every week).
- immediate removal of infected pods.
- infected pods taken well away from the plantation and buried
- regular brushing and shade thinning, to improve ventilation in the plantation.
- spraying with copper solutions (e.g. **bordeaux mixture**) during the wet season.

**b. Stem canker**

This is a fungus which attacks the stem. It enters the tree through wounds in the bark, such as those caused by poor pruning technique. (See section 12 - Pruning.)

Infected trees must be cut down and removed from the plantation.

**c. Phellinus noxius (Dieback or brown root disease)**

This is a brown fungus which grows from the roots up the bark, causing the tree to die from the top to the bottom.

Infected trees (including roots) must be removed and taken away from the plantation.

This disease is present on Malakula, Pentecost and Santo.

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## 13. Harvesting

A well maintained plantation should start bearing pods 4 to 5 years after planting.

It takes about 5 to 6 months from flowering to formation of a ripe pod.

### Timing of Harvest

Harvesting has to be done all year round, but peaks in pod production occur at certain times. Therefore it is necessary to harvest more frequently during these time of peak production.

During May to September: harvest every 2 weeks

During October to April: harvest every 4 weeks

When there are many ripe pods it may be necessary to harvest every week.

### Technique of Harvesting

1. Pick **only ripe pods** i.e. those that are **completely yellow** with no green left.

**Immature pods** do not contain enough mucilage for fermentation. (See section fourteen).

Overripe pods can contain seeds which have already begun to germinate in the pod, this too gives poor fermentation.

2. Always harvest using a sharp knife, or a pair of secateurs. A special hooked knife, with a long handle, can be used for high pods (see figure 22).

**N.B. Do not climb the tree to cut off pods.**

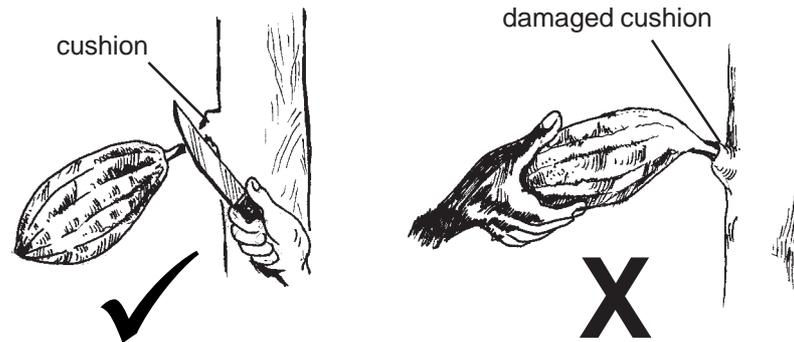
A clean cut will reduce the chance of disease infection.

**Figure 22**                      **Hooked harvesting knife**



- 
3. Never pull the pods off by hand. This may damage the flower cushion and lead to decreased production and/or disease infection.

**Figure 23**                      **Correct and incorrect harvesting techniques**



4. When harvesting ripe pods you should also cut off all diseased pods e.g. Black pod disease.

Ideally you should use a different knife to remove diseased pods, or there is a risk of spreading disease with the harvesting knife.

Diseased pods should be kept separate from the good pods, and then burnt or buried away from the plantation.

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## 14. Breaking the Pod and Sorting the Beans

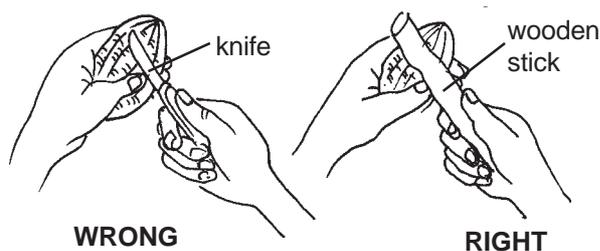
Pods should be broken and beans sorted as soon as possible after harvest.

Leaving pods for more than 6 days after harvest can cause beans to begin germinating in the pod.

### Breaking Pods

- i. Do not break pods in the plantation. Heaps of broken pods can provide ideal sites for the build-up of black pod disease.
- ii. Pods should be carried to where the beans are to be fermented, and broken there.
- iii. Break open the pods using a piece of wood. Do not use a knife because beans are easily cut, (see figure 24).

**Figure 24 Correct and incorrect ways of opening a cocoa pod**



- i. Remove beans from the pod.
- ii. Sort out all those beans which are:
  - germinating
  - damaged
  - broken
  - diseased.

These beans should be thrown away (except for diseased beans which should be buried).

- iii. Ideally the good beans should be stored overnight in a clean bag or bucket before fermenting.

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## 15. Fermentation

Fermentation is a process by which bacteria are allowed to break down the mucilage surrounding the beans.

This also has a *curing* effect on the beans.

### Reason for fermenting

- i. It removes the sticky mucilage layer.
- ii. It improves the flavour (taste) of the cocoa.
- iii. It kills the embryo of the bean, preventing germination. (Beans which have germinated are useless.)

### Changes occurring during fermentation

- i. Many complicated chemical changes take place causing:
  - improvement of flavour
  - change of colour in the **kernel**.

At the beginning of fermentation the kernel is **purple** but by the end it is **reddish brown**.

- ii. The kernel and seed coat (testa) separate.
- iii. The embryo is *killed*.

This happens because the temperature of the beans rises during fermentation from 45° to 50°C.

- iv. The smell of the beans changes from sweet to acid. Then the acid smell becomes less strong.

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## Methods used for fermentation

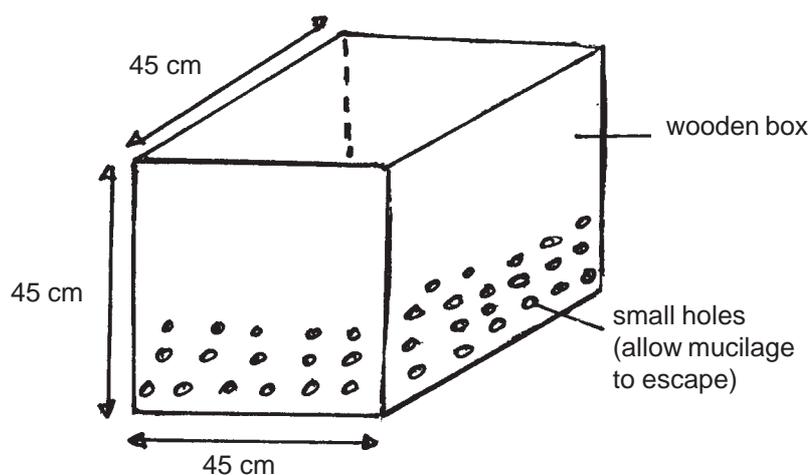
There are 2 main methods:

### 1. Box method

This is more suitable for larger plantations.

A box similar to that shown in figure 25 will hold about 80 kilograms of wet beans.

**Figure 25**                      **Box for fermenting**

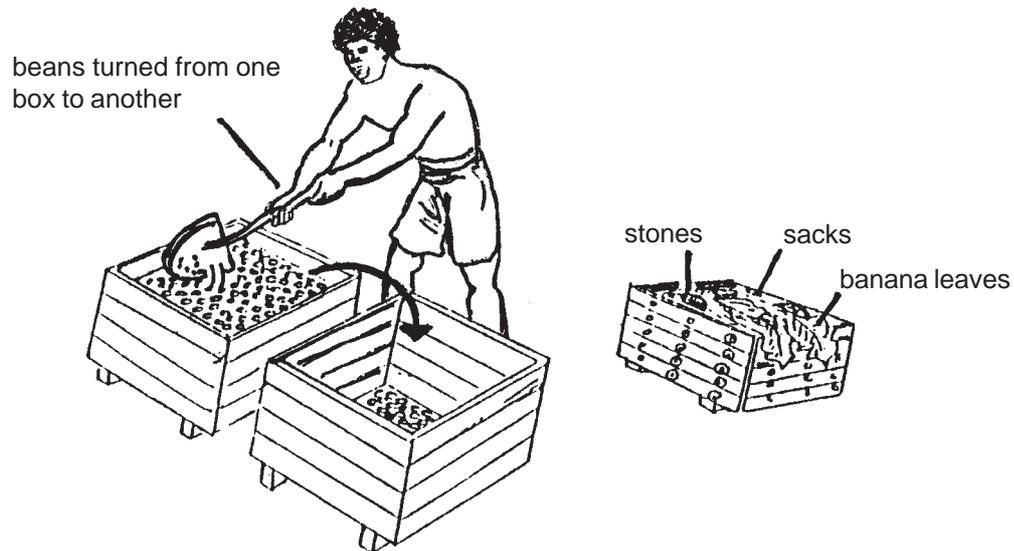


## Procedure

- i. Fill the box with beans, which were removed from their pods the previous day.
- ii. Cover the beans with banana leaves (see figure 26).
- iii. Weigh down the leaves with stones or pieces of timber. This is to keep out air.
- iv. Leave the box for 2 days, then mix the beans by turning them into another box (see figure 26).
- v. Turn or mix the beans every 2 days. Turning is important to ensure that:
  - the temperature inside the box rises quickly to the necessary level (45°-50°).
  - beans ferment evenly (if not turned, those beans which stay at the edge of the box will take longer to ferment).
- vi. Fermentation should be finished after 6-8 days.

N.B. See figure 26 on the opposite page.

**Figure 26 Turning of cocoa beans during fermentation**



### **Method for smallholder**

This is a method suitable for smallholders harvesting only small quantities of beans.

### **Procedure**

- i. A hole is dug in the ground large enough to hold the amount of beans to be fermented.
- ii. The hole is lined with banana leaves.
- iii. The banana leaves at the bottom must contain holes to allow escape of the mucilage.
- iv. Fill the hole with beans.
- v. Weigh down the leaves on top with stones or pieces of timber.
- vi. Stir the beans every 2 days.

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### **How to know if fermentation has finished**

After 6 days check a sample of beans.

If fermentation has finished, about  $\frac{3}{4}$  of the sample should:

- i. have seed coats which easily separate from the kernel.
- ii. have kernels which are reddish brown (not purple). This can be seen by cutting through the seed.
- iii. smell slightly acid (not strongly acid).

If, after 6 days, fermentation is not complete, leave the beans to continue fermenting, and re-check them every 12 hours until fermentation is complete.

N.B. Overfermentation: if beans are allowed to ferment for too long, they can begin to decay, which will spoil the flavour and reduce quality.

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## 16. Drying the Beans

Fermented beans must be dried before storing or selling.

If they are not dried, beans will be attacked by fungus and be mouldy, which reduces their quality.

After fermentation beans have a moisture content of about 60%. This must be reduced down to below 8%.

Below 8% moisture content beans can be safely stored.

### Methods used for drying

#### Sun Drying

Fermented beans are spread out in the hot sun.

They should be turned every day.

After 10 to 15 days they should be dry.

This technique is useful for smallholders with only a few beans to dry, but it has the following problems:

- i. during the rainy season it can be difficult to dry the beans
- ii. beans can be easily attacked by rats and other pests.

However, it is an inexpensive way to dry the beans.

#### Hot Air Drying

There are 2 important points to remember:

- i. **Do not** use a copra drier - This is because the smell of copra is easily picked up by the cocoa, which reduces its quality.
- ii. **Do not** allow smoke to pass through the beans - This is because the cocoa will pick up the smell of the smoke which also reduces its quality. So the ends of the drier must be well sealed, and the smoke ventilated away from the drying bed.

N.B. Before building a drier for cocoa, contact your local Agriculture Field Officer for advice.

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## Procedure

- i. The beans must be dried slowly.

The ideal air temperature for drying is 50° C.

If the temperature is too high:

- beans can be burnt
- water evaporates too quickly from the beans, leaving acid inside.

- ii. During the drying, beans should be stirred at regular intervals.

- iii. To check if beans are dry enough:

- squeeze a handful of beans, if they crack in half easily then they are dry.
- The insides of the beans must be dry and brittle.

Usually 4 days in the hot air drier is enough.

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## 17. Storage

Only store beans of good quality.

After drying throw out any beans which are:

- flat and thin
- broken
- mouldy or slaty\*
- damaged by insects (e.g. weevil)
- germinated

Beans should then be stored in **clean, new** bags. Each bag should contain 53.5 kg of beans.

### Area for storage

Beans should be stored in a place which is:

- dry
- above the ground (away from rats)
- well ventilated
- clean
- does not contain any other strong-smelling substances e.g. copra, benzene, pesticides, fertilizer. The smell from such products can contaminate the dried beans and reduce their quality.

The bags should not become contaminated with any rubbish e.g. dust, stones, leaves etc.)

- \* **Slaty beans** are beans which have been dried without being fermented. Such beans have **grey** coloured cotyledons (kernels) which crumble (break up) easily.

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## 18. Grading and Marketing

Grading is done to determine the quality of a cocoa sample. This will in turn determine the price paid to the farmer.

Beans are graded by the plant quarantine section of the Department of Agriculture as they arrive in Port Vila or Luganville.

Beans are graded according to their size and quality.

- a. Size: this is determined by weighing 100 beans. 100 beans should weigh more than 100g.
- b. Quality: the beans are cut lengthwise, through the middle, and checked for defects such as: mould, insect damage, slaty beans etc.

Many farmers in Vanuatu achieve a poor grading because their beans are too small. It is very important to remove small beans.

VCMB buys and markets all the cocoa in Vanuatu.

### Licensed fermentaries

A licensed fermenter is licensed by the Department of Agriculture to purchase wet, harvested beans from a producer, and then ferment and dry the beans for him.

### Current Prices

Prices currently paid by VCMB for graded cocoa are:

Grade 1	150 vatu/kg
Grade 2	140 vatu/kg
Substandard	1000 vatu/kg

### Current returns

According to a recent census the average smallholder is selling 365 kgs of cocoa from an average of 0.7 hectare (an average yield of 520 kilogram/hectare).

At current prices this is likely to earn the farmer 50,000 vatu.

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## Glossary

<b>amelonado</b>	the most common variety of cocoa, it is recommended for Vanuatu
<b>autoshading</b>	when cocoa trees shade themselves
<b>black pod</b>	fungus disease attacking cocoa pods
<b>blue water</b>	tree used to provide temporary shade for cocoa ( <b>bislama</b> = <b>nananarr</b> )
<b>bordeaux mixture</b>	chemical spray used to control Black Pod
<b>cherelle wilt</b>	fertilised flowers dropping off tree
<b>C.I.R.A.D.</b>	Centre International de Recherches Agronomiques pour le Développement
<b>chupon</b>	shoot which grows below the jorquette
<b>criollo</b>	kind of cocoa not grown in Vanuatu
<b>cushion</b>	small bump on the trunk or branch of cocoa tree from which flowers grow
<b>fan branches</b>	main branches which grow from the jorquette of a cocoa tree
<b>feeder roots</b>	shallow, lateral roots which absorb most of the nutrients and water for cocoa tree
<b>flat beans</b>	cocoa beans which are too thin for processing
<b>forastero</b>	kind of cocoa of which Amelonado is the main variety
<b>glyricidia</b>	tree used to provide temporary shade for cocoa
<b>gramoxome</b>	chemical spray used to control weeds in cocoa plantation
<b>husk</b>	fruit wall for cocoa (pod)
<b>jorquette</b>	place at the top of a cocoa tree from which fan branches grow
<b>kernel</b>	another name for cotyledons of a cocoa bean
<b>mixed cropping</b>	growing two or more different types of crop on the same piece of land at the same time
<b>mucilage</b>	sweet, sticky substance which surrounds cocoa beans inside the pod
<b>nananarr</b>	tree used as temporary shade
<b>Ontec 8</b>	chemical spray for containing Rose Beetle

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<b>phellinus noxius</b>	fungus disease of cocoa
<b>pod</b>	fruit of the cocoa tree
<b>ring weeding</b>	weeding in a circle around the cocoa plant
<b>rose beetle</b>	insect pest attacking cocoa
<b>secateurs</b>	hand instrument which can be used for harvesting cocoa
<b>slaty bean</b>	beans which are dried without being fermented
<b>sowing at stake</b>	technique of sowing cocoa seeds direct into the plantation
<b>staminode</b>	sterile part of a cocoa flower, similar in appearance to a stamen
<b>stem canker</b>	fungus disease attacking the stems of cocoa
<b>trinitario</b>	a hybrid kind of cocoa
<b>V.C.M.B.</b>	Vanuatu Commodities Marketing Board
<b>Warfarin</b>	chemical used to poison rats