



DEPARTMENT OF AGRICULTURE
BUREAU OF PLANT INDUSTRY

CACAO

PRODUCTION GUIDE



ACAO

Scientific Name: *Theobroma cacao*

Common Name: Cacao tree and Cocoa tree

INTRODUCTION

Cacao has a rich and interesting history as a food and its usage dating back thousands of years. At one point in Central America, cacao was so ubiquitous that it was used as a form of currency.

Cacao differs greatly from what most have experienced in the form of processed chocolate. Cacao is a very interesting in that it has the most complex make up of any known natural food source. It is an excellent source of magnesium and very high levels of antioxidants. While these components are broken down slightly processing, there are low temperature processed raw cacao powders which attempt to render a high quality product that remains nutrient rich. These raw powders are an easy way to get started enjoying the wonderful properties of cacao. Nibs and beans have even higher concentrations of antioxidants and can be fun to have around and can be put to good use making granola and other goodies (use them as a replacement for chocolate chips).

Production decreased by annual average rate of 1.88 percent from 2006 to 2010. Average annual decreases in area planted, number of bearing trees and yield per bearing tree were 2.23 percent, 1.37 percent and 0.52 thousand metric tons, 2.23 percent lower than the level of 5.13 metric tons in 2009. The top producing regions and their contributions to the national out put in 2010 were Davao Region, 69.86 percent, Northern Mindanao, 11.05 percent, Caraga, 2.47 percent; and Eastern Visayas, 2.43 percent.

DESCRIPTION

Cacao leaves are alternate, entire, unlobed, 10–40 cm (4–16 in) long and 5–20 cm (2–8 in) broad.

The flowers are produced in clusters directly on the trunk and older branches; they are small, 1–2 cm (1/2–1 in) diameter, with pink calyx. While many of the world's flowers are pollinated by bees (Hymenoptera) or butterflies/moths (Lepidoptera), cacao flowers are pollinated by tiny flies, *Forcipomyia* midges in the order Diptera. The fruit, called a cacao pod, is ovoid, 15–30 cm (6–12 in) long and 8–10 cm (3–4 in) wide, ripening yellow to orange, and weighs about 500 g (1 lb) when ripe. The pod contains 20 to 60 seeds, usually called "beans", embedded in a white pulp. The seeds are the main ingredient of chocolate.

Recommended Varieties:

National Seed Industry Council Registered Varieties

There are many varieties of cacao but the National Seed Industry Council has registered and approved only 9 varieties/clones of cacao. NSIC approved clones are the following:

- BR 25 (CC-99-05)
 - Reddish (red with green) pod color when still young that turns yellow as it matures
 - Leaves are elliptical in shape with wavy leaf margins
 - Leaf length and width ratio is 11.0 cm is to 4.04 cm.
 - First flowering starts at 16.12 months and fruiting follows at 17.70 months
 - Pod index is 23.1pods/kg of dried beans. Pod length is 17.02 cm and has width of 7.07.

- K 1
 - It has elliptical shape with smooth shape with smooth leaf margins
 - Leaf length is 31.31 cm with a mean width of 13.44 cm
 - It flowers at 23.20 months and bears fruit at 25.10 months
 - Pod shape is Amelonado with a superficial ridges and a smooth surface. Rugosity also appears in some cases.
 - Pod index is 19.20 pods/kg of dried beans. Pod length is about 17.97 cm and has width of about 8.67 cm.
 - It has a pod wall thickness of around 1.80 cm.
 - Bean color is violet and a hundred beans weigh about 182 grams.
 - It is moderately resistant to known insect pests and diseases.

- K 2
 - Leaf shape is elliptical with smooth leaf margins.
 - Leaf length is 32.73 cm with a mean width of 12.52 cm.
 - It flowers at 21.10 months and bears fruit after three months or at 24.12 months
 - Pod shape is Amelonado and is red in color while still young and becomes yellow/ orange when mature.
 - It has pod wall thickness of around 1.40 cm with 34 beans per pod.
 - Pod index is 25 pods /kg of dried beans
 - It is moderately resistant to known insect pest and diseases.

- UIT 1 (CC-99-02)
 - It has an elliptical leaf shape with wavy leaf margin.
 - Leaf length and width ration 22.36 cm to 8.13 cm.
 - It flowers of age of 16.80 months in the stage of first fruiting.
 - Pod shape is Cundemor. Pod length is 20.07 cm and width of 8.65 cm
 - Pod is yellow when old from original color of green color when still young with wall thickness of 1.02 cm.
 - Moderately resistant to insect and pest diseases.

- ICS 40
 - Leaf shape is elliptical with wavy leaf margin.
 - Leaf length and width ratio is 29.95 cm is to 10.01 cm.
 - Starts to flower at the age of 17.63 months and fruiting follows at 19.63 months and fruiting follows at 19.63 months.
 - Pod shape is Cundeamor described as a variety with elongated cylindrical fruit with ridges, a rugose surface, pronounced bottleneck and sharp point.
 - Pod color is green when young and turns yellow when mature with wall thickness of 1.35 cm.
 - Pod index is 16.2 pods/kg with 44 beans per pod. Canopy diameter is 195 cm.
 - Bean is stiped.
 - Moderately resistant to insect pest and diseases.

Other NSIC approved Varieties are:

- UF 18
- S 5
- K 4

Cultural Management

Soil Requirement

Soil is made up of 50% loamy soil, 30% clay and 20% silt. Deep soil is about 15cm, highly favors the growth of cacao. pH is 5.0 – 6.5

Propagation of Planting Materials

Propagation by seeds – nursery involves the production of a large number of high quality planting materials, either by seeds or by vegetative parts, of recommended clones of cultivars with uniform and vigorous growth and free from pests.

- Seed Selection – collect a seeds from ripe and healthy pods and preferably collected from the seed garden. Choice a seeds that are uniform in size. Select big seeds since the possibility is high that they would produce vigorous and fast growing seeds.
- Seed germination – the usual practice is to plant the prepared seeds directly into the prepared poly bags in the nursery.

Procedures in Seed Germination

- Remove the mucilage that cover the seeds by rubbing the seeds with sawdust or sand to loosen the mucilage
- Wash the seeds to effectively remove the mucilage
- Drain the water

- Keep it in a moist and well ventilated place to pre- germination

Sowing the Pre- Germinated Seeds

- Collect those seeds that show sign of germination two days after
 - Sow the pre- germinated seeds not more than 1 cm deep in the prepared polybags. It is important to plant the germinated seeds soon when the germs are 1 cm long. If planting is delayed, the root or shoot may easily be damaged.
- Vegetative propagation – involves the choice of method of propagation; patch budding, community nodal grafting, conventional grafting and side grafting method.

Climatic Requirement

Ideal rainfall for cacao cultivation ranges from 1250 to 3000 mm per annum, preferably 1500-2000 mm with dry season of not more than 3 months. Temperature ideal for cacao lies between a mean maximum of 30-32°C and mean minimum of 18°C. Altitude of the area should lie between 300-1200 meters above sea level. Suitable temperature is generally found in an altitude up to 700 m. Cacao thrives best in areas under Type IV climate which has an evenly distributed rainfall throughout the year.

On the other hand, weeds growing along spaces in between the blocks may be controlled by cutting down with scythes. The use of herbicide is not recommended. Therefore weeding could be done manually or by mulching with available materials such as rice hull.

Fertilizer application:

Fertilizer is carried out after the first leaf hardens and should be based on the result of soil analysis. If analysis is not available, incorporate 15-35 grams of ammonium phosphate (18-48-0) per bag depending on the size of polybag. The use of granular fertilizer is also done when the leaves are dry to avoid leaf scorching.

Culling/Selection:

To ensure uniform growth and development of the seedlings to be planted in the field, cull out the poor-growing seedlings in the nursery. This practice may be carried out by removing the bags containing seeds which did not germinate and small, crinkled seedlings.

Transplanting:

To reduce the seedling shock during transplanting, it is necessary to rotate the polybag to a few degrees one week before field planting. It is done for the seedlings whose leaves have hardened and especially for those which roots have penetrated the

ground. Watering has to be done for a few days later. Field planting must be started at the onset of the rainy season. Unless irrigation is available, field planting during the dry season is not advisable.

Pruning:

Pruning can be achieve three objectives, namely: a. Increase cacao pod production; b. reduce pest and disease infestation c . control the shape and height of the tree, to ensure easy access for harvesting.

Pruning of young trees (less than 3 years) is limited to removal of weak fan branches, leaving 3 to 4 equally spaced fan branches, a few months after formation of the jorquette. Chupons, or sides shoots, growing at the base of the stem have to remove regularly. For older trees more than 4 years that have never be pruned before, farmers must able to learn how to determine branches that should be cut off and perform the pruning using the correct method.

How to determine the branches to prune

- Branches that are growing downwards.
- Those that are curve
- ing, crossing from one side of the crown to the other, thus they do not grow outward from where the stem but zigzagging irregularly
- Branches that have large roofing parts or that are heavily wounded

How to cut large branches
(more than one centimeter in diameter)

- Use a saw, not a machete
- Saw close to the stem, to make the cutting vertical to the direction of the stem
- Use sharp pruning tools because it is important that the cut is sharp and clean.

Direction to Determine the Branches to be Cut Off.

- Pruning cocoa trees can increase production, make tree maintenance easier, and reduce pest infestation and diseases.
- Maintenance pruning starts with regularly removal the low hanging.
- Second remove regularly the chupons (shoots) on the stem.
- Also remove all shoots and additional branches that are within 60 cm of the jorquette. Removal of shoots is necessary to avoid production of non- essential branches.
- It is important to remove regularly all dead, diseased and badly damaged branches
- Top pruning of the highest branches (up to 4 meters) in order to keep the tree short for easy regular harvesting and maintenance.
- It also recommended to open the center of the tree by pruning in the shape of a champagne glass in order to reduce humidity and increase sunshine.
- The CPB does not like the sunshine and increased wind. The additional sunshine to the stem will increase flowering as well.

- The best time for heavy pruning is after the high production cycle, approximately one month before the rainy season. After pruning it is recommended to apply fertilizer.
- Pruning has to be done regularly and correctly, results in more pods on the tree with less pest infestation.

Types of Pruning

- Formative Pruning
- Maintenance Pruning
- Pest and Diseases Pruning

Rehabilitation of Cacao Trees

There are several conditions wherein an existing cacao farm needs to be rehabilitated to improved yield or the quality of beans especially if the plantation contains many unproductive trees known as borders. Free borders are trees which develop few pods in spite of profuse flowering while others produce limited flowers and pods. The other is when trees are already old and become less productive, and when the varieties/ clones planted are generally low yielding and producing poor quality beans.

Side Grafting

A less productive tree can be renewed to produce more pods by grafting branches from selected trees unto the unproductive tree. The trees to be subjected for rehabilitation are either young trees which have never produced many pods, a very old tree which no longer produce as many pods as they used to. The scion or budwood should come from trees selected for both high productivity and resistant tolerant to major pest and diseases. A tree can have up to the three side grafts, but these must be made one month apart. In the other words, the second side graft should be made at least one month after the first side graft.

This consists of:

- ability to prepare scion or budsticks
- ability to prepare the tree for grafting
- putting the graft in place
- taking care of the new graft until it has grown firmly into the tree
- maintaining the grafted branches

Materials needed:

- notebook and pencil
- sharp pruning knife
- sharpened machete
- raffia/plastic wire
- plastic bags
- transport for participants to the field
- unproductive cacao trees for training purposes.

Procedure:

1. Identify old, less productive but healthy trees to be subjected to side- grafting.
2. Gather bud sticks from bud wood garden.
3. Prepare the bud sticks to be used for side grafting
4. Make first horizontal deep cut on the main trunk
5. Shave bark downward into the cut
6. Make sure original cut is through the bark to the white wood inside.
7. Make two cuts downward from the horizontal cut.
8. Create “window” by peeling the bark neatly and cleanly downward to reveal the cambium.
9. Insert bud stick into the “window”
10. Tie window closed
11. Make sure graft is tied securely.
12. Cover side graft with plastic bag and tie tightly against the tree with raffia.
13. Remove plastic cover after one month
14. Productive side grafted trees 30 months (2 1/2 years) after grafting

Plant Nutrition

Cacao requires 16 essential elements to complete its life cycle and most of them are obtained by the plant from the soil. The deficiency of any of these elements would result in reduction in growth and production.

Providing proper amount of shade will reduce the nutrient needs of cacao due to reduced metabolism as a result of decreased light intensity. Among the essential elements needed by cacao are the nitrogen(N), phosphorus (P),potassium (K),calcium (CA) and magnesium (MG) are the most deficient in many soils. These elements are badly needed during the following period

Element	Function	Most needed during
Nitrogen	vegetative growth	the onset of rainy season and three months later
Phosphorus	increases flowering	the onset of rainy season
Potassium	enhances flower	set before flowering & fruit development and three months later
CA & Mg	lengthen life of leaves	the onset of rainy season

Regularly apply organic fertilizer around the base of the plant particularly to during the wet season, to hasten the vegetative and reproductive growth of cacao trees. The pod bearing cacao trees without shade requires 100kgN,20 P kg K per hectare year.

Management of Common Cacao Pests and Diseases

1. CPB Control Method (Cacao Pod Borer, caused by *Conopomorpha crameella*)

Cultural Practices to control are:

- Regular harvesting in order to break the lifecycle of the pest.
- Sanitation; which includes to bury all empty cacao pod husks, but also to also to remove all other diseased pods, black pods, and pods eaten by animals from the trees.
- Pruning; to increase the sunlight which the pest does not favor.
- Bagging or sleeving of the young pods with newspaper and staples (or plastic bag)
- Fertilizer, to increase the general health of the tree and in addition increasing cacao production.

2. VSD Control Method (Vascular Streak Die back ,caused by *Oncobasidium theobromae*)

- Sanitation pruning – cut off infected branches at 30 cm below the infested area , and burn cuttings.
- Nurseries should use polyethylene roofing to ensure spores cannot land on the seedlings
- Shade on the cacao trees should be reduced to lower humidity.
- Plant VSD tolerant varieties.

3.Black Pod Rot and Canker Control Method

- Frequent harvesting to avoid pathogen spirulation
- Harvest all the infested, dead and mummified pods and ideally destroy or bury them
- Prune the cacao trees and shade trees to reduce humidity.
- Have a good drainage system so that the spores cannot spread in puddles of water.
- Trees that have died due to tree canker should be cut down and destroyed.

- Scraping off the bark from the infected area and put pain or soap on it.

4. Helopeltis Control Method (Helopeltis, a sap-sucking bug)

- Generally sanitation of farm
- Regular harvesting.

5. Stem borer Control Method (Zeuzera)

- Cut off infested branches at 40 cm below the lowest larvae hole. These branches should be destroyed.
- After pruning of an infested tree, big branches, especially those with stem borer holes, should be burned.
- The hole can be covered or plugged with mud or wood to prevent the larva to come out, so that it cannot feed and hatch, or cannot breathe.
- Poking the larvae out with a piece of wire.
- Squirt some soap solution in the exit hole. After a while, the larva will emerge from the driven hole, probably driven out by the unpleasant soap fume. Catch and kill the stem borer.

Managing Common Cacao Pest and Diseases

- Pruning – to increase production, makes tree maintenance easier and reduces losses due to pest and diseases, allowing farmers to maximize their return.
- Complete and Frequent Harvesting – if done throughout the year to break the life cycle at the larva stage and reduce Cacao Pod Borer (CPB)
- Sanitation – bury pest-infected pods thereby killing the larva still in the pod to prevent damage to healthy pods in the farm.
- Maintain Tree Nourishment – makes trees stronger to be able to produce larger pods, encourages flowering and allowing the tree to produce more pods.

Harvesting and Post Harvest Operations

The production of quality cacao beans involves proper processing of wet beans with special references to the standard of quality required by the market involves:

- **Pods harvesting** - cacao pods are formed, grow to maturity and ripen in 160 to 180 days. Physical indicator of ripened pods is the change in color, green turns yellow, or dark – red purple to yellow or orange. During the removal from the tree the care should be taken so that damage should be lessened but the most important, the flower cushions should not be damaged so that they were able to produce flowers and pods for several years.
- **Pod Breaking and Removal of Seeds** – open the pods after storing using wooden baton or devised pod splitter to avoid injury or cutting the seeds may

allow molds and insects, and broken beans are also discarded during sorting and grading.

The Fermentation Process

There is no chocolate flavor in cacao beans without proper fermentation. During fermentation, compounds (precursors for chocolate flavors) are formed that will react each other during the roasting to form chocolate flavor. It is a process that occurs in the two steps and two locations. Fermentation of sugar in pulps surrounding in cacao beans. Sugar transformed into alcohol and then to acetic acid and acetic acid, produced externally, penetrate through the husk and cause biochemical reactions in the bean that are responsible for the formation of chocolate flavor precursors. There are factors influencing the fermentation, and these include: ripeness of the pods, quantity of the beans, type of cacao and duration of fermentation.

Cacao should undergo five (5) days fermentation, with first turn done after 48 hours, and second turn over after another 48 hours, will normally result in lower acidity. Fermentation progress is assessed by the odor, and internal and external color of the beans.

Types of Fermentation

- **Fermentation boxes** - of 85 cm x 85 cm and 45 cm deep can accommodate approximately 300 kg of wet beans. But as a rule all boxes with dimensions between 75cm x 75 cm x 45cm deep or 1.0m x 1.0 m and 45 cm deep should give reasonable fermentation for 200 kg to 400 kg of wet cocoa. For smaller quantities during the low crop seasons it would be the best to have box with removable dividers, maybe quartered by removable boards to be able to get 100 kg if the same box is just divided by two.
- **Fermentation Heaps** – In small volume operation, fermentation can be done in heaps. Wet beans are placed on banana leaves or bamboo mats provided with adequate perforations. Each batch should be raised from the ground by underlying the wood or any material as base arranged with adequate spaces to allow drainage and aeration. The heap is covered with the same material or perforated sacks that are held in place. The heap should be adequately covered to prevent rainwater, if any, from entering the mass and avoid contamination or formation of molds.
- **Basket Fermentation**- the basket is lined with banana leaves or perforated plastic sacks to provide drainage. The basket should be raised slightly off the ground. Wet beans of 50 kilos or more in a batch completely ferment in 5-6 days with mixing or turning after 48 hours from loading the wet beans. The basket containing cacao seeds should be kept under roof to prevent rainwater from entering the mass of seeds. It is important to cover the baskets or boxes with jute bags to avoid losses of heat which is crucial for good fermentation. When the fermentation period is completed, the beans are ready for drying.

Cacao Beans Drying Process

Drying of fermented cocoa beans is the process of reduction moisture from 45 % to 7 %.It is actually an extended part of fermentation . As long as there is enough moisture, flavor forming reactions in the beans continue as well browning reaction that oxidize polyphenols and leads to reduction of astringent and bitter taste .During the drying process, the excessive acidity is eliminated through evaporation of acetic acid through the outer skin while it is still moist.

Sun - Drying

The best for sun drying is good quality of cacao beans .But under Philippine condition, the most practical approach could be combined sun- mechanical drying: starting with sun drying for 1-2 days, and finishing with artificial drying. This approach could address the lowering of cost compared with using artificial dryers alone, while attaining high quality dried fermented cacao beans.

Sun drying may also be done on multi-purpose drying pavements provided that the cacao beans are placed on the receptacles made of plastic, or bamboo mats sheeting on the cement floor. In some areas , trays made of bamboo, or plastic screen are used. This is important to avoid contamination with dust and other foreign materials or accumulation of foreign waste that could result to low quality, or worst , rejected cacao beans.

Artificial Dryer

In using artificial dryers, the temperature should not exceed 60 C so that the removal of water from the beans would be gradual. Rapid drying tends to make the beans retain excessive amounts of acetic acid that the results to acidic beans.

Artificial dyers designed with dimensions of 6.0m x 12.0m could accommodate approximately 5,000 kgs of fermented beans with cocoa beans layer of 21 cm .Artificial dryers are used in most commercial operations to overcome the dependence on weather conditions.

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