

# COCOA

## CULTIVATION PRACTICES



**CENTRAL PLANTATION CROPS**

**RESEARCH INSTITUTE**

**Kasargod - 671 124, Kerala**



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## Introduction

Cocoa (*Theobroma cacao L.*), a native of the Amazon region of South America was known as the beverage crop even before tea and coffee. The main cocoa producing countries are Ghana, Nigeria, Ivory Coast, Brazil and Cameroon. The cultivation of cocoa on a large scale started in India in the early 1970s. It is mainly grown as a mixed crop component in coconut and arecanut plantations. It is also grown as an under-storey crop in partially cleared forests. At present, cocoa is grown in an area of 14,618 hectares with a production of 7,837 tonnes. Kerala accounts for 71 per cent of the area and 80 per cent of the production. Though Andhra Pradesh has the second highest area, Karnataka is ranked second in production.

## Climate and Soil

Cocoa is a crop of the tropics. Though the tree grows between 20°N and 20°S latitude, the main growing areas are situated within 10°N and 10°S. Cocoa is grown from sea level up to an elevation of about 500 m. It comes up best upto 300 m above sea level. Ideally, cocoa requires a minimum of 90-100 mm rainfall per month with an annual precipitation of 1500-2000 mm. Rainfall can be supplemented with irrigation during the dry periods. Cocoa requires an equitable climate. It grows within a temperature range of 15 - 39°C and temperature around 25°C is considered the most optimum. It cannot be grown commercially in areas where the minimum temperature falls below 10°C and the annual average temperature is less than 21°C. Cocoa plants need high humidity around them at all times.

Cocoa requires deep and well drained soil for easy penetration of the roots. Poorly drained soil is inimical to this crop. A great proportion of the cocoa of the world is grown on clay loam and sandy loam soil. It thrives on wide range of soil types with pH ranging from 4.5 - 8.0 with the optimum being 6.5 - 7.0.

## Shade

Cocoa, whose natural environment is the lower storey of the forest, requires shade when young and also to a lesser extent when grown up. Young cocoa plants grow best with 50 per cent of full sunlight. It grows very well in the partially shaded condition prevailing in the arecanut and coconut gardens of our country. As the tree matures, its shade requirements are reduced.

## Varieties

Commercial cocoa has two major types, 'Criollo' and 'Forestero' which differ mainly in the colour of the cotyledons. 'Criollo' beans are plumpy and white when fresh and turns cinnamon coloured on fermentation. 'Forestero' beans are flat and the colour changes from purple when fresh to dark chocolate brown on fermentation. The dark red 'Criollo' pods have a rough surface, pronounced point and a thin wall while 'Forestero' pods are green when immature and yellow when ripe, thick walled, melon-shaped with rounded ends and smooth inconspicuous ridges. The 'Criollo' variety possesses a bland flavour and pleasant aroma, while 'Forestero' possesses a harsh flavour with bitter taste. 'Criollo' ferments fully in three days, while Forestero variety needs six days. The 'Criollo' variety has a lower adaptability and less yield potential. It is highly susceptible to diseases. Hence, its cultivation is not encouraged anywhere in the world. 'Forestero' variety forms most of the commercial cocoa of the world.

Other types of cocoa include (1) 'Trinitario' from Trinidad which is said to be a hybrid between 'Criollo' and 'Forestero' with highly variable pod characteristics (2) 'Amelonado', a 'Forestero' type bean with a melon-shaped pod, cultivated in West Africa and (3) 'Amazon', a relatively new type collected from the Amazon forests which has good vigour and high yield potential.

## High yielding accessions

Studies conducted at Central Plantation Crops Research Institute, Regional Station, Vittal, have shown some Cocoa accessions and hybrids as high yielding ones. They are Na33 x ICS 89, I-14 x NC42/94, I-14 x II-67, I-56 x II-67, I-56 x III-105, 'Amel' x Na33, II-67 x NC 42/94, II-67 x NC42/66 and NC45/53. Biclinal and polyclonal orchards are being maintained for producing high yielding  $F_1$  hybrid seedlings.

## Planting Material

**Selection of Seeds:** Fresh beans should be used for sowing as cocoa seeds lose their viability soon after they are taken out of pods.

**Nursery techniques:** The seeds should be rubbed with dry sand or wood ash to remove the mucilage and are planted with their pointed ends upwards. Seeds may be sown in plastic bags (25 x 15 cm size, 150 gauge thickness). The seedlings will be ready for transplantation to the main field after about three to four months.

As cocoa shows considerable variability in the field, it is recommended that seedlings may be obtained only from government nurseries or similar dependable sources.

**Grafts:** Softwood grafting is found successful and suitable in cocoa. The method consists of cleft grafting of scions to seedlings of 40-45 days old raised in polybags. The scions are collected by prior defoliation of shoots of comparative thickness. The selected scions are inserted into the cleft portions of the root stocks so that they fit in tightly and the grafted site is tied with polythene strips. These grafts are kept in shade and watered daily. Graft union will take place within one month. All the shoots emerging from the root stocks are to be removed periodically. The grafts are planted in the pits as in the case of

seedlings after three months of hardening. About 80 per cent success is expected if grafting is done in October.

### **Establishment of Plantation**

**Selection of the site:** As a pure plantation, cocoa can be planted in forest lands by thinning and regulating the shade suitably. It can be grown in arecanut and coconut gardens as a mixed crop.

**Planting time:** It can be planted either in the beginning of the south-west monsoon (May-June) or at the end of the monsoon (September).

**Spacing and planting:** Cocoa seedlings are to be planted in pits of 75 cm<sup>3</sup> filled with compost. Cocoa is planted in 2.7 m x 5.4m spacing in areca garden planted with a spacing of 2.7m x 2.7m. Both areca and cocoa require shade during summer of two seasons after planting. When cocoa is to be raised as a mixed crop with coconut, single hedge or double hedge system of planting can be adopted. In single hedge system, cocoa can be planted 2.7 m apart in a single row between two rows of coconut, while in double hedge system it can be planted 2.5 m apart in paired rows between two rows of coconut palms.

**Manuring:** An annual application of 100g N, 40g P<sub>2</sub>O<sub>5</sub> and 140g K<sub>2</sub>O per tree in two equal splits is recommended. During the first year of planting, the plants may be given one third the above dose, while in the second and third year two third and full dose of fertilizers are applied. The fertilizer is applied in two splits, the first dose in April-May and the second dose in September-October. Fertilizer may be applied uniformly around the base of the tree upto a radius of 75 cm and forked and incorporated into the soil.

**Irrigation:** Cocoa plants are sensitive to drought. Hence, irrigation is essential for better performance of the crop. During summer, the crop is to be irrigated at weekly intervals. When it is grown as a mixed

crop with arecanut, the crop is to be irrigated once in a week during November-December, once in 6 days during January-March and once in 4-5 days during April-May with about 175 litres of water. Cocoa responds well to drip irrigation with 20 litres of water/day/tree.

**Pruning:** The cocoa trees should be pruned regularly to maintain a good canopy shape. It is optimum to have a canopy area of 15-20 m<sup>2</sup>. For this, all the fan branches arising from the main stem are nipped off up to a height of about 1.0-1.5m or cut in the initial years of their growth. Later, only the thin and dried up branches are periodically removed. Operations like harvesting and spraying will be easier if the height of the tree is maintained at the second storey level.

Cocoa grows in a series of storeys. The chupon or vertical growth of the seedlings terminates at the jorquette where four or five fan branches develop. Further, chupon develops just below the jorquette and continues its vertical growth till another jorquette forms and so on. When the first jorquette develops at a height of about 1.5 m the canopy will form a height convenient for harvesting and other operations. It is desirable to limit the height of the tree at this level by periodical removal of chupon growth. A second jorquette may be allowed to develop if the first one formed is very close to the ground. Generally, 3-5 fan branches are developed at each jorquette. When more fan branches develop, one or two weaker ones may be removed. The branches badly affected by pests and diseases also should be removed.

### **Plant Protection**

**Pests:** More than 50 insect pests are recorded on cocoa in India. The more important insect pests and vertebrate pests are described below.

**Mealy bugs:** (*Planococcus lilacinus* Ckll. and *P. citri* Risso):

Most important insect pest of cocoa in India is mealy bug. The adult females and young ones feed on the tender shoots, flower cushions, flowers, cherelles and pods by sucking the sap. Seedlings and young plants colonised by the mealy bugs show retarded growth and excessive branching at undesired height. They also cause cushion abortion and wilting of cherelles. The population build up of the bugs is more during the summer months. Spot application of the loci of the colonies with fenthion (Lebaycid) 50 ml in 100 litres of water or dimethoate (Rogor) 160 ml in 100 litre of water is the best method of magagement. If recurrence of the pest is noticed, a second round of spraying is recommended after an interval 30 days. A number of natural enemies are found to feed on these mealy bugs viz., coccinellids, lycaenids, cecidomyids etc.

**Stem borer** (*Zeuzera coffeae* Nietn.): The red borer of coffee bore into the branches and trunks of cocoa trees. The portion of branch above the point of entry of the pest dries up. Control of the pest is best achieved by pruning off and destroying the attacked branches and by local application of carbaryl paste.

**Aphids** (*Toxoptera aurantii* B de F.): These colonise on the underside of tender leaves, succulant stem and flower buds and small cherelles. Heavy infestation brings about premature shedding of flowers and curling of leaves. The natural enemies associated with the aphid effect better control normally. In severe cases of infestation spraying with dimethoate (Rogor) at 160 ml in 100 litre of water is suggested.

**Stem girdler** (*Glenea* sp): The larvae of this beetle tunnel the bark first and penetrate deeper making galleries. On younger trees, the pest attack occurs at the jorquette which normally results in the drying or breaking of the portion above. Mechanical extraction of the larvae

and topical treatment with carbaryl paste are sugg measures.

**Leaf eating caterpillars:** Several caterpillars and semiloopers feed on the tender foliage, shoots and green bark of cherelles and pods. They include bagworms, caterpillars of *Lymantria* sp., *Euproctis* spp; *Dasychira* sp. and two species of loopers. They may cause serious leaf damage on seedlings and young trees. If the damage is very severe, spraying could be given by mixing 16 ml dimethoate in 10 litres of water.

**Leaf eating beetles:** Leaf eating beetles mainly *Myloceros* sp. and *Popillia* sp. feed on tender leaves causing a series of irregular holes. They make sporadic appearance in some areas after rains and cause serious damage. Grubs of these beetles dwell in the soil. Drenching the soil with a suspension of carbaryl (Sevin 50% WP) at the rate of 20 g in 10 litres of water is effective in controlling the pest.

**Rodents:** Rats (*Rattus rattus*) and squirrels (*Funambulus tristriatus* and *F. palmarum*) are the major rodent pests of cocoa. They cause serious damage to the pods. The rats usually gnaw the pods near the stalk portion whereas squirrels gnaw the pods in the centre. The rats are known to damage the mature as well as immature cocoa pods whereas the squirrels damage only the mature ones. They gnaw the pods and feed on the mucilage covering of the beans. The rats can be controlled by keeping 10 g bromadiolone (0.005%) wax cakes on the branches of cocoa trees twice at an interval of 10-12 days.

Squirrels are best controlled by trapping with wooden or wire mesh single catch 'live' trap with ripe coconut kernel as the bait. The success is more if trapping is carried out during the lean periods of the crop (September-November) and when the alternate foods such as paddy, cashew apples and jack fruit are not available. The traps



are to be inspected daily and the trapped animals are to be killed to minimise the chances of communication with other animals. Timely harvest of the pods will help in increasing the efficiency of poison baiting as well as trapping.

### Diseases

**Black pod disease (*Phytophthora palmivora*):** It occurs in all the cocoa growing areas in south India during the south-west monsoon period with the maximum incidence in July-August. The infection occurs anywhere on the pod surface. Pods of all ages are susceptible. Pods damaged by rodents/insects or injured while harvesting, pruning or carrying out other cultural operations, are more prone to infection by the pathogen.

Infection appears as chocolate brown spot which spreads very rapidly and soon occupies the entire surface of the pod. As the disease advances, a whitish growth of fungus consisting of fungal sporangia is produced over the affected pod surface. Ultimately, the affected pods turn brown to black. The internal tissues as well as the beans become discoloured as a result of infection. The beans in the infected pods approaching ripeness may escape infection because they are separated from the husk on ripening. The beans in such pods can be saved by timely harvesting.

The disease can be prevented by spraying one per cent Bordeaux mixture at the onset of south-west monsoon rains and thereafter at least twice during the monsoon season at monthly intervals. Frequent removal and destruction of all infected pods will help in reducing the disease incidence to some extent. Over crowding of trees and thick shade should be avoided.

**Canker (*P. palmivora*):** The cankers appear either on the main trunk, jorquettes or fan branches. The earliest symptom is the appearance of

a greyish brown water soaked lesion on the outer bark. A reddish brown liquid oozes out from these lesions which later dries up to form rusty deposits. The tissues beneath the outer lesion show reddish brown discolouration due to rotting. When these cankers girdle the main stem or branches, die-back symptoms appear and ultimately the tree dies. The infection may also spread from the infected pod to the peduncle and then to the cushion and bark.

All infected pods should be removed and destroyed. The disease can be controlled in the early stages by removing the infected tissues and applying Bordeaux paste. Good drainage system is to be provided in the garden.

**Charcoal pod rot (*Botryodiplodia theobromae*):** This disease, though known to occur throughout the year, becomes severe during summer months. Pods of all ages are susceptible. Infection appears as dark brown to black coloured spot. The affected pods turn black and remain on the tree as mummified fruit. The internal tissues are rotten and the affected beans turn black. Spores appear in masses forming a soot. Infection takes place through wounds. Spraying with one per cent Bordeaux mixture is recommended to control this disease.

**Pink disease (*Pellicularia salmonicolor*):** It is characterised by the presence of a pinkish powdery coating on the stem. It causes wilting of shoots, shedding of shoots, shedding of leaves and finally drying up of the branch. The disease persists from season to season through dormant mycelium inside the bark and in the cankerous tissues. It is checked by pruning the affected branches and swabbing the cut ends with Bordeaux paste. The disease can be prevented by spraying regularly with 1% Bordeaux mixture.

**“Cherelle” wilt:** The shrivelling and mummifying of some young fruits are a familiar sight in all cocoa gardens. In the early stages the

fruits lose their lustre and in four to seven days the fruits shrivel. The fruits may wilt but do not abscise. Many factors are associated with this malady. The most important factors are: insects damage, diseases, nutrient competition, over production etc. Hence, the remedial measures will depend upon the nature of the causative factors involved.

**White thread blight (*Marasmius scandens*):** White thread blight is observed in some of the gardens in Kerala and Karnataka states. The white mycelial threads of the fungus spread longitudinally and irregularly along the surface of the young stem or branches. Growth of the fungus is very rapid under favourable condition of high humidity and the infection enters leaf lamina along the petioles. On the leaf lamina it spreads extensively. The affected leaves turn dark brown. These dead leaves eventually get detached from the stem, but are found suspended by the mycelial thread. The extensive death of the young branches and suspended leaves are the common field symptoms.

Thread blight disease can be controlled effectively through removal and burning of the affected parts. Removal of heavy shade in mixed crop cocoa gardens will also help in the control of the disease.

**Vascular streak die-back (*Oncobasidium theobromae*):** This disease is mainly found in Papua-New Guinea and Malaysia. It is also reported from some parts of Kerala. The first indication of the disease is a characteristic yellowing of one or two leaves on the second or third flush behind the growing tip. Diseased leaves fall within a few days of turning yellow. The other leaves on the shoot soon show similar symptoms. When the infected shoot is split lengthwise there is always a characteristic brown streaking of the woody tissue extending well beyond the region of yellowed leaves. The disease is spread by spores produced on diseased branches which are released only at night under certain specific climatic conditions and are dispersed by wind. A

spore, which is deposited on a young flush can initiate a new infection. The disease can be controlled by the disposal of diseased branches and regular pruning of chupons on the trunk. Cocoa nurseries should not be located near the diseased trees.

**Zinc deficiency:** Incidence of zinc deficiency is observed in many cocoa gardens in Kerala, Tamil Nadu and Karnataka states. The initial symptom is chlorosis of the leaves. This appear in patches and in advanced stages the green areas are found only along the vein margins, giving a vein-banding appearance to the leaves. Affected leaves show mottling and crinkling with wavy margin. Most of the younger leaves become narrow, much reduced in size and sickle shaped showing characteristic 'little leaf' symptom. Symptoms on twigs include rosette and die-back. Shortening of inter nodes causes a rosette type of growth. In severe cases, premature defoliation followed by dieback of the branches occurs. Zinc deficiency can be corrected by foliar spray of a mixture of 0.3% Zinc sulphate and 0.15% (w/v) lime.

### Harvesting

Cocoa produces flowers from the second year of planting onwards and the pods take about 140-160 days to ripen. Each pod will have 25-45 beans embedded in a white pulp (mucilage). Generally cocoa gives two main crops in a year i.e., September-January and April-June though off-season crops may be seen throughout the year especially under irrigated condition.

Ripe pods are to be harvested without damaging the flower cushions by cutting the stalk with the help of knife. The harvesting is to be done at regular intervals of 10-15 days. The damaged and infected pods are to be separated to ensure better quality of beans after processing. The harvested pods should be kept for a minimum period of two days before opening for fermentation; however, the pods should not be kept beyond four days. For breaking the pods, wooden

billet may be used. After breaking the pods crosswise, the placenta should be removed together with husk and the beans are collected for fermentation.

### Processing

**Fermentation:** Fermentation of cocoa beans is essential to remove the adhering mucilagenous pulp to develop flavour and aroma precursors, reduce bitterness, kill the germ of the seed and to loosen the testa. Different methods of fermentation are (1) box (2) heap (3) tray and (4) basket. However, box and basket methods are recommended depending on the quantity of beans to be fermented.

**Box method:** This method is more applicable in large estates or central fermentaries. The boxes of 60 cm x 60 cm x 45 cm made of wood and having reapers at the bottom to allow the sweating from the pulp to drain out and to provide aeration, are used. The boxes could be arranged in tiers for transferring beans from one to the next in line below. Two detachable wooden planks are provided on one side of the box for transferring (mixing) the beans by removing the planks.

The beans are loaded in fermentation box and covered with banana leaves or gunny. The mixing of beans is effected while transferring to the next after 24 hours. The mixing is done to facilitate uniform fermentation and to maintain proper temperature, moisture and aeration during fermentation. The temperature of the fermentation mass will rise to 42-48°C after about 48 hours of fermentation. Again transferring of beans is done at 72 hours of fermentation and the final transferring is done after another day's fermentation. A total of six days (144 hours) are required to complete the fermentation.

**Basket method:** Bamboo or cane baskets of suitable size could be used for fermenting small quantity of beans. One or two layers of

banana leaves are placed at the bottom with provision to drain the sweating. The basket is filled with the beans and the surface is covered with banana leaves. A small weight is placed over the banana leaves. The basket is placed over a raised surface to facilitate drainage of the sweating for one day. Later the basket is covered with thick gunny bags. The beans are mixed thoroughly on the third and fifth days and again covered with gunny. The fermentation will be completed at the end of the sixth day and the beans are withdrawn for drying.

**Drying:** After fermentation, the beans can be dried by sun-drying or artificial drying. The fermented cocoa beans have considerable moisture (55-69%) and the drying rate is dependent upon temperature and the air flow.

**Sun drying:** Sun drying should be adopted as far as possible, as it gives superior quality produce when compared to that by artificial drying. The fermented beans are spread in thin layer over a bamboo mat or cement floor and dried for 5-6 days. The beans are to be stirred from time to time for uniform drying. The moisture content of well dried beans is around 6 to 7 per cent.

**Artificial drying:** During the monsoon period, artificial drying is to be adopted. Electric ovens or conventional Samoan type drier could be used. The duration of artificial drying varies from 48-96 hours. The drying of beans at high temperature should be avoided as it results in low quality end-product. Slow drying in the initial stage gives better quality beans. Mould growth is to be prevented during drying as it affects the appearance of the beans.

**Electric oven:** The beans are to be dried for 8-10 hours at 50-55°C for the first two days, followed by continuous drying at 60°C. The total drying period will be 72-96 hours. The beans are to be stirred at regular intervals for uniform drying and to prevent clump formation.



**Samoa type drier:** The temperature should be maintained around 60-70°C for the first 48 hours and then temperature can be raised to 80°C to reduce the bean moisture to 6 per cent. The end-point of drying can be determined by rubbing the beans with hand after cooling when it should produce a crackling noise.

**Grading and storage:** The dried beans after cooling to room temperature should be cleaned before storage. The flat, slaty, shrivelled, broken and other extraneous materials are removed. The cleaned beans are packed in fresh polythene-lined (150-200 gauge) gunny bags. The bags are kept on a raised platform of wooden planks. The beans should not be stored in rooms where spices, pesticides and fertilizers are stored as they may absorb the odour from these materials.

### **Yield**

In India, cocoa cultivation is confined to Kerala, Karnataka and Kanyakumari district of Tamil Nadu. The crop is mostly grown in the interspaces of coconut and arecanut gardens as a mixed crop. When cocoa is grown under arecanut with a spacing of 2.7m x 5.4m, one hectare area accommodates about 680 trees. Under normal cultivation practices, each cocoa tree yields about 2 kg dry beans annually.

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