

COCOA



Cultivation Practices



Central Plantation Crops Research Institute
(Indian Council of Agricultural Research)
Kasaragod - 671 124, Kerala, India





Flower cushions on cocoa tree trunk



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COCOA CULTIVATION PRACTICES

Cocoa (*Theobroma cacao* L.) is one of the important commercial plantation crops of the world. It is a native of the Amazon region of South America and was known as the beverage crop even before tea and coffee. The main cocoa producing countries are Ghana, Nigeria, Ivory Coast, Brazil, Malaysia 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 in coconut and arecanut plantations and as under-storey crop in partially cleared forests. At present, cocoa is cultivated in an area of 17,800 hectares in India with a production of about 10,000 MT. 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 ranks second in production. It has great potential to be introduced in other states where coconut, arecanut and oil palm are grown. Cocoa being a profitable mixed crop, it is important to understand the package of practices to be followed and adopt the same for maximizing the income per unit area.

Agrometeorology

Cocoa is a crop of the humid tropics. Though it 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 500m. It comes up best up to 300m above mean sea level. Ideally, cocoa requires a minimum of 90-100 mm rainfall per month with an annual precipitation of 1500-2000 mm. Cocoa requires an equitable climate. It grows within a temperature range of 15-39°C and optimum temperature is around 25°C. It cannot be grown in areas where the minimum temperature falls below 10°C and the annual average temperature is less than 21°C. Cocoa needs high humidity throughout the year for optimum growth.

Cocoa requires deep and well-drained soil for easy penetration of the roots. Poorly drained soil is inimical to this crop. It is predominantly

grown on clay loam and sandy loam soils. It thrives well on wide range of soil types with pH ranging from 4.5-8.0 with optimum being 6.5-7.0.

Varieties/clones and hybrids

Commercial cocoa has two major types, 'Criollo' and 'Forastero' which differ mainly in the colour of the cotyledons. 'Criollo' beans are plumpy and white when fresh and turns cinnamon coloured on fermentation. 'Forastero' 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 'Forastero'



Criollo



Forastero

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 with bitter taste. 'Criollo' ferments fully in three days, while Forastero 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. 'Forastero' 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 'Forastero' with highly variable pod characteristics (2) 'Amelonado', a 'Forastero' type with a melon-shaped pod, cultivated in West



Hybrid II-67 x NC 29/66



Hybrid II-67 x NC 42/94



Clone : NC 45/53



Hybrid I-56 x II-67

**High yielding Clones**

Clones	Genotype	Dry bean yield/tree/year (Kg)	Single bean weight (g)	Dry bean yield / ha (Kg)
I-14	Jarangau Red axil	1.18	1.17	803.00
I-56	PA7 x Na32	1.12	1.20	761.00
III-105	Amel x Pa7	1.07	1.06	728.00
NC42/94	T86/2	1.05	1.08	714.00
NC45/53	P10 x P1	1.149	1.05	781.00

High yielding Hybrids

Hybrids	Dry bean yield/tree/year (Kg)	Single bean weight (g)	Dry bean yield / ha (Kg)
II-67 x NC42/94	1.245	0.99	847.00
II-67 x NC29/66	1.478	1.06	1006.00
ICS6 x Sca6	1.145	0.95	779.00
I-56 x II-67	1.481	1.00	1007.00

Africa and (3) 'Amazon', a relatively new type collected from the Amazon forests which has good vigour and high yield potential.

Studies conducted at Central Plantation Crops Research Institute, Regional Station, Vittal, have shown some Cocoa accessions and hybrids as high yielding ones. Identified clones are I-14, I-56, III-105, NC42/94 and NC45/53 and promising hybrids 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 NC42/94, II-67 x NC29/66 and ICS6 x Sca6. Biclinal and polyclonal orchards are being maintained for producing high yielding F_1 hybrid seedlings.

Production of planting material and Nursery techniques**Raising of seedlings**

Good quality planting material is an important input to obtain/ensure high yield and quality of cocoa. Fresh beans should be used for sowing as cocoa seeds lose their viability faster. 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 with 150 gauge thickness). The seedlings will be ready for planting in the main field after about three to four months.

Vegetative propagation

The need for asexual or vegetative propagation arises when the seedling progeny of selected trees are variable. Cocoa being a self-incompatible crop in general, the population will have lot of variations. Hence, softwood grafting is found successful and suitable in cocoa to breed true to type planting materials. The method consists of cleft grafting of scions to seedlings of



Softwood method of grafting

75-90 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 rootstocks so that they fit 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 rootstocks 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 to 90 percent success is expected if grafting is done during August to October.

Clonal orchards and production of F1 hybrids:

The purpose of clonal orchard is to produce seeds of known parentage and proven performance. Seed is the cheapest and most convenient planting material in cocoa. Seedlings develop into trees with a desired habit of growth. However, seedlings resulting from open pollination show large variability. Therefore, the parents used in the seed gardens are selected based on the performance of progeny trials. The identification of best combiners involves large number of crosses, their screening and selection both at the seedling growth and adult reproductive stages. Selected parents are normally propagated vegetatively. The female parent should be self-incompatible. The desired crosses can be ensured either by hand pollination or by the proper design of the seed garden (establishing the clonal gardens) with known parentage where natural pollination is relied. With two self-incompatible

parents, all the pods resulting from cross-pollination can be used as F1 hybrid seeds. Where one parent is self-incompatible, seed is collected only from the self-incompatible parent and in such cases pollen parent is planted in a ratio of one to five female parent trees. Clonal orchards must be isolated to some extent from other cocoa plantations and a distance of 200m is considered sufficient to prevent undesired cross pollination in order to produce genetically pure planting materials.

Establishment of Plantation

Selection of the site

Cocoa can be grown in arecanut and coconut gardens as a mixed crop. It can also be planted in forest lands by thinning and regulating the shade suitably.

Planting Time

It can be planted either in the beginning of the Southwest monsoon (May-June) in low rainfall areas or at the end of the monsoon (September) in high rainfall areas.

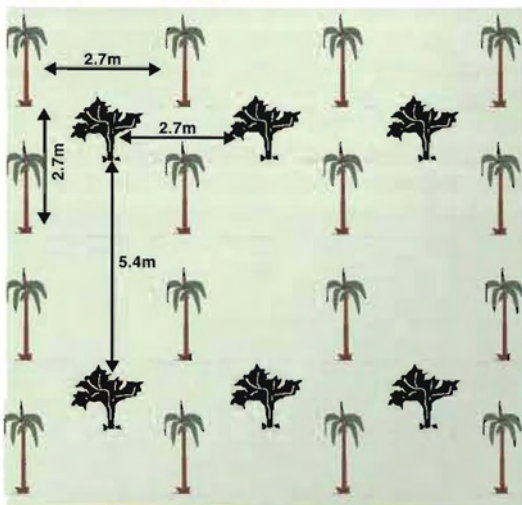
Spacing and planting

Cocoa seedlings are to be planted in pits of 60 cm³ filled with compost. Cocoa is planted in 2.7m x 5.4m spacing in areca garden planted with a spacing of 2.7m x 2.7m. While establishing new garden a spacing of 3.3m x 3.3m can be followed for both areca and cocoa. Both the crops require shade during summer season 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

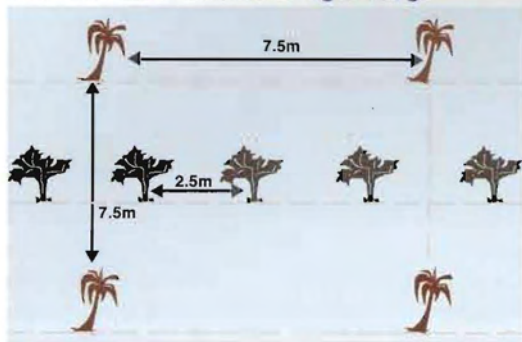




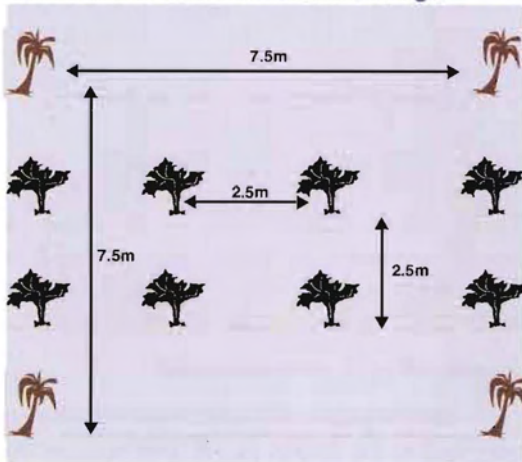
Cocoa under Arecanut



Cocoa under coconut : Single hedge



Cocoa under coconut : Double hedge



single row between two rows of coconut, while in double hedge system it can be planted 2.5m apart in paired rows between two rows of coconut palms.

Shading

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 percent of full sunlight. It grows very well in the partially shaded condition prevailing in the arecanut and coconut gardens. As the tree matures, its shade requirements are reduced.

Manuring

An annual application of 100g N, 40g P_2O_5 and 140g K_2O 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

Fertilizer recommendation for cocoa (g/tree)

Fertilizer	First year	Second year	Third year and afterwards
Nitrogen	33	66	100
Phosphorous	13	26	40
Potash	46	92	140
Urea	72	144	220
Rock phosphate	65	130	200
Muriate of potash	77	154	230

full doses 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 up to a radius of 75 cm and forked and incorporated into the soil.



Irrigation

Cocoa is sensitive to water stress. Hence, irrigation is essential for performance of the crop during post monsoon season. 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 liters of water. Cocoa responds well to drip irrigation with 20 liters of water/day/tree.

Pruning

Cocoa plants are grown under the shade of arecanut and coconut plantations. It is therefore necessary to regulate the canopy size and shape of plants so that the main crop is not affected. Proper and systematic pruning is essential in cocoa cultivation.

Formation pruning is done in young plants, mainly to adjust the height of first jorquette. The jorquette is allowed to form at a height of 1-2 meters that will help in easy cultural operations. A low jorquette will make it difficult to carry out cultural operations. So a jorquette at 1.5 to 2.0 m height is preferable. This pruning will decide the number of jorquettes per tree, fan branches per jorquette and height of first jorquette.

Pruning in mature cocoa includes two types viz., sanitary pruning and structural pruning.

In **sanitary pruning** diseased or unnecessary branches and water shoots are removed to maintain the health and vigour of the tree. It is also necessary to prune infected branches with diseases like witches broom or vascular streak dieback. Sanitary pruning include removing all unnecessary chupons, dead branches, epiphytes, climbing plants, ant nests, diseased and rodent-damaged pods and over ripe pods. Chupons must be removed very often. Other work can most suitably carried out when there is no crop on the trees because minimal disturbance would then be caused to flowers, cherelles and pods.

Structural pruning is done to shape the canopy to desired size and architecture. For optimum productivity, proper canopy management to maintain shape and size is required.

In either case care must be taken, when removing large branches to ensure that exposed wood surface is not damaged, to prevent the entry of fungi or insects. Apply fungicides (Bordeux paste) immediately after the pruning.

Pruning of seedling material

For pruning the seedling material following steps are to be followed. First adjust the height



of first jorquette between 1 to 2 meters and 3-4 fan branches are retained with vertical height restricted to first jorquette. It is mainly to shape



the canopy for desired shape, which should be umbrella-shaped. The canopy spread of 3.8 to 4.0m and height 2.7m are the ideal canopy architecture for optimum yield.

Pruning of graft plants/material

Emphasis is being given to planting of graft materials in the recent years. This is obtained

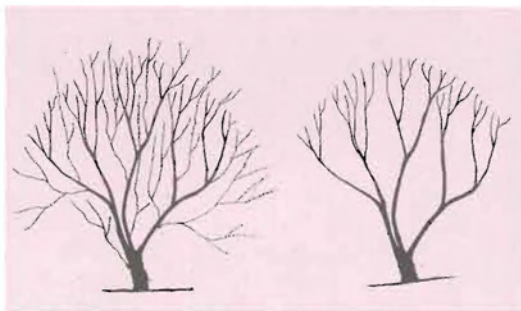


from soft wood grafting method using high yielding cocoa clones.

For pruning the graft material after first year of planting, primary pruning should be done to obtain a supporting framework of one or more upward growing main stems. Then drooping or inward growing branches to be removed.



Secondary pruning is suggested to develop well-shaped canopy and desired canopy should be maintained in umbrella shaped form with about



3.8m to 4.2m spread and 2.7m height depending upon the space and main crop in which cocoa is under planted/grown.

It is important to note that the maximum leaf area should be maintained with pruning practices to avoid self-shading. Pruning is usually done annually in July-August. The proper pruning of cocoa ensures adequate ventilation in garden; maintain tree height, makes spraying and harvesting operations easier. When cultivated as mixed crop under palms a maximum of two-storey canopy architecture may be maintained. Cocoa trees should be pruned regularly to maintain a good canopy shape. It is optimum to have a canopy area of 15-20m².

Plant protection

Pest management:

More than 50 insect pests are recorded in India. Among the major pests infesting cocoa, the more important insect pests and vertebrate pests are described below.

Mealy bugs (*Planococcus lilacinus* Ckll. and *P. citri* Risso): It is the most important insect pest of cocoa in India. 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 colonized 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) 50ml in 100 litres of water or dimethoate (Rogor) 160 ml in 100 litre of water is the best method of management. If recurrence of the pest is noticed,



Mealy bugs



Tea mosquitoes



a second round of spraying is recommended after an interval 30 days.

Tea mosquitoes (*Helopeltis antonii*): These mosquitoes usually damage the pods. Infested pods develop circular water soaked spots around the feeding punctures. These punctures subsequently turn pitch black in colour. Deformation of pods occur because of multiple feeding injuries. The spraying of Endosulfan (0.05%) is recommended for control of Tea mosquitoes attack.

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.): They colonise on the underside of tender leaves, succulent stem, flower buds and small cherelles. Heavy infestation brings about premature shedding of flowers and curling of leaves. Spraying with dimethoate (Rogor) at 160 ml in 100 litres 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 tropical treatment with carbaryl paste are suggested as control measures.

Leaf eating caterpillars: They include bagworms, caterpillars of *Lymantria* species and two species of loopers. Several caterpillars and semiloopers feed on the tender foliage, shoots and green bark of cherelles and pods. 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 *Mylloceros* species 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 20g in 10 litres of water is effective in controlling the pest.

Rodents: Rats (*Rattus rattus*) and squirrels (*Funambulus trisriatus* 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 center. The rats are known



Rat damage

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



Squirrel damage



the mucilage covering of the beans. The rats can be controlled by keeping 10g 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 jackfruit are not available. Timely harvest of the pods will help in increasing the efficiency of poison baiting as well as trapping.

Disease management

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 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 discolored 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 southwest 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.

Preparation of 1% Bordeaux mixture

Dissolve 1 kg copper sulphate crystals in 50 liters of water. In another vessel containing 50 liters of water, prepare milk of lime with 1 kg quick lime. Pour the milk of lime into the copper sulphate solution slowly stirring the mixture all the while. Test the mixture before use for the presence of free copper, which is harmful to the palm by dipping a polished knife in it. If the blade shows a reddish colour, add more lime till the blade is not stained when dipped afresh in the mixture. Always use wooden or earthen or copper vessels for the preparation of Bordeaux mixture.

Preparation of 10% Bordeaux mixture paste

For preparation of Bordeaux mixture paste, 100 g copper sulphate and 100 g quick lime each are dissolved in 500 ml of water separately and mixed thoroughly.

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 discoloration due to rotting. When these cankers girdle the main stem or branches, dieback 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 spots 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 percent Bordeaux mixture is recommended to control this disease.

Pink disease (*Pellicularia salmonicolor*): It is characterized 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 luster 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, diseases, for nutrients 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 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 exclusively. 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 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: Zinc deficiency is observed in many cocoa gardens in Kerala, Tamil Nadu, Andhra Pradesh and Karnataka states. The initial symptom is chlorosis of the leaves. This appears 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 and sickle shaped showing characteristic 'little leaf' symptom. Symptoms on twigs include rosette and dieback. Shortening of internodes 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 and processing

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.

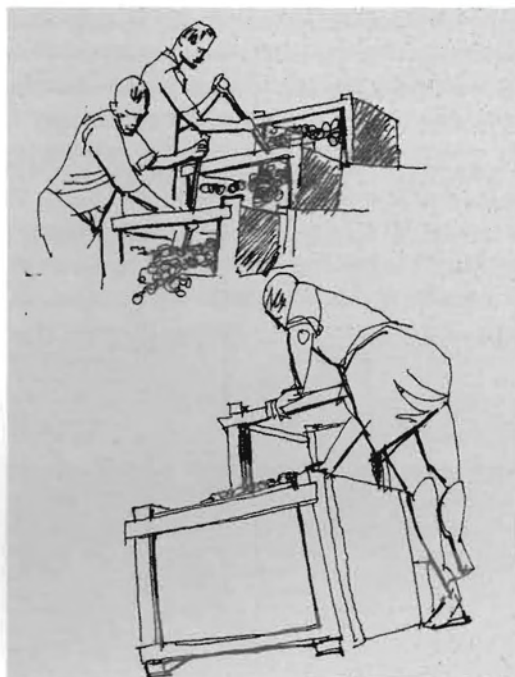
Ripe pods are to be harvested without damaging the flower cushions by cutting the stalk with the help of knife. The harvesting is to be done at regular intervals of 10-15 days. The damaged and infected pods are to be separated to ensure



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.

Fermentation: Fermentation of cocoa beans is essential to remove the adhering mucilaginous pulp to develop flavour and aroma precursors, reduce bitterness and kill the germ of the seed and to loosen the testa. Different methods of fermentation normally followed 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.

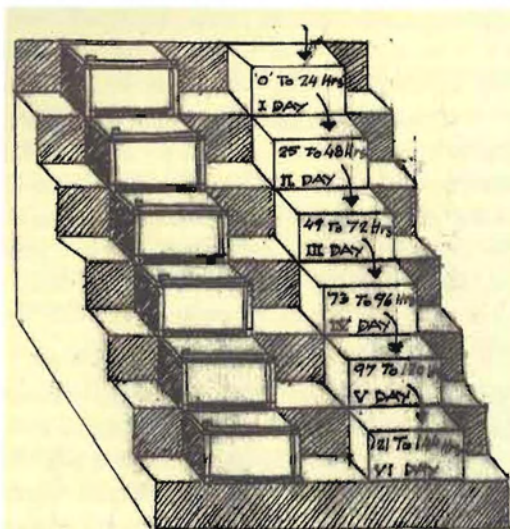
Box method: This method is more applicable in large estates or central fermentaries. The boxes of 60 cm x 60 cm x 45 cm made of wood and having reapers at the bottom to allow the sweating from the pulp to drain out and provide aeration are used. The boxes could be arranged in tiers for transferring beans 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.

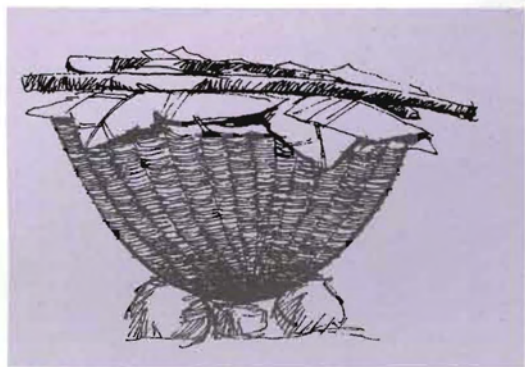
The beans are loaded on fermentation box and covered with banana leaves or gunny bags. The mixing of beans is effected while transferring to the next box after 24 hours. The mixing is done to facilitate uniform fermentation and to maintain proper temperature, moisture and aeration during fermentation. 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 bags.



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 using electric oven. The fermented cocoa beans have considerable moisture (55-69%) and the drying rate is dependent upon temperature and the airflow.

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 (Electric oven): During the monsoon period, artificial drying is done using Electric oven. 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 quality of the beans.

In the Electric oven 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.

Dry beans grading and storage: The dried beans after cooling to room temperature should be cleaned before storage. The flat, slate, shriveled, 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.

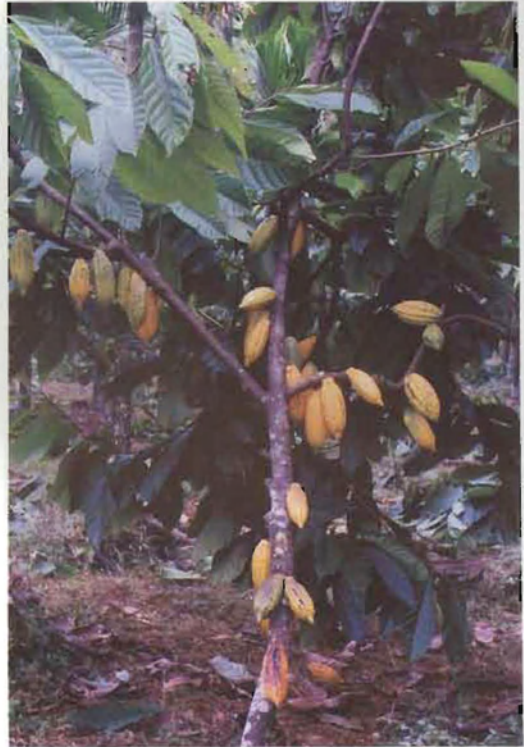
Yield potential

In India, cocoa cultivation is not only confined to Kerala, Karnataka and Kanyakumari district of TamilNadu but also extended to irrigate





tracts of Andhra Pradesh, Goa and Maharashtra. The crop is mostly grown in the interspaces of coconut and arecanut gardens as a mixed crop. Under normal cultivation practices, each cocoa tree yields about 1-2 kg dry beans annually.



When cocoa is grown under arecanut with a spacing of 2.7m x 5.4 m, one hectare area accommodates about 650 trees with the yield potential of 650 to 1300 Kg dry beans.



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