

ALL ABOUT COCOA GROWING

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Cocoa, *Theobroma cacao*, is a cash crop recently introduced into cultivation in India. It is one of the popular beverage crops after tea and coffee. It is a native of Amazon valley of South America and now cultivated almost in the entire tropical belt. At present cocoa is grown largely in Ghana, Nigeria, Sierra-Leon, Camoroon, Brazil, Ecuador, West Indies and Malaysia. In India, it is cultivated in an area of 8,000 ha. mainly as a mixed crop in coconut and arecanut gardens. Maximum area is in Kerala State, followed by Karnataka and Tamil Nadu. The present annual production of cocoa beans in the country is only about 400 tonnes per annum. The production will go up at a faster rate in the coming years when more and more plantations attain full bearing stage.

There are two major varieties of cocoa—Criollo and Forestero. Criollo, which is the "fine" or "flavour" cocoa has red or yellow, thin-walled, pointed and warty pods. Fresh beans are large and plump with white or pale purple colour and possess a blend flavour and pleasant aroma. Criollo cocoa is mainly used for blending and for making special quality cocoa products. Because of poor adaptability, susceptibility to disease, and low yield, its cultivation has not spread notably anywhere in the world. However, attempts were made to popularise this variety in Kerala State in the early 1960's. These gardens are now being cut and replanted with Forestero.

Forestero forms the bulk of the commercial cocoa of the world. It is characterised by smooth, melon shaped, thick walled inconspicuously ridged and furrowed pods which are green when immature and yellow when ripe. The fresh beans are rather flat and dark purple and has a harsh flavour and bitter taste.

There are different types of cocoa which have derived either from Forestero or from cross pollination between Forestero and Criollo. Amazon and Amelonade types which have derived their name

from the place of origin or from the fruit shape belong to the Forestero variety while Trinitario is a mixed type representing various degrees of Criollo and Forestero.

Forestero variety alone is now recommended for cultivation in India.

Climate and Soil:

Cocoa is a crop of humid tropics requiring well distributed rainfall. A minimum of 90 to 100 mm. rainfall per month with an annual precipitation of 1500—2000 mm. is ideal. However, it can also be grown in other regions by supplementing rainfall with irrigation during dry periods. Cocoa tolerates a minimum temperature of 15°C and a maximum of 40°C, but temperature around 25°C is considered as optimum. It can be grown in places from sea level upto an elevation of 600 m.

Cocoa grows on a wide range of soils. Loose soils which allow root penetration and movement of air and moisture are necessary for cocoa cultivation. Moisture must be retained in the soil during the dry season as cocoa requires regular supply of moisture for proper growth. Majority of the cocoa gardens in the world are established on clay loams and sandy loams. Even though cocoa can be grown on soils with pH range from 4.5—8.0, it thrives better in neutral soil.

Shade:

Proper nourishment to plants and better soil moisture conditions lessen the shade requirement and produce better crops. In general cocoa prefers more shade when young and less when mature. It is observed that young plants grow best with 50% full sunlight. It flourishes well in the partially shaded conditions prevailing in the arecanut and coconut gardens where humidity is high and temperature low.

Raising seedlings:

Cocoa is generally propagated from seeds for the establishment of gardens. Polythene bags are the best containers for raising cocoa seedlings. Specification of bags according to the nursery periods are given under:

Nursery period in months	Bag size		Gauge	Colour	Filled weight
	Length	Width			
	cm	cm			kg
3-4	25	18	150	clear	2.7
4-5	30	20	200	black	4.5
5-6	35	23	250	black	6.8
Over 6	40	25	250	black	9.0

Before sowing, bags are filled with good top soil containing sufficient organic matter. They are then arranged in beds of about 80-100 cm width with 15 cm wide pathways. Fresh beans should be used for sowing, as cocoa seeds lose viability soon once they are taken out from the pods.

Before sowing, the seeds are rubbed with dry soil or wood ash to remove the mucilage. The beans are planted with pointed end upwards. To avoid wastage of polythene bags and to produce more number of good quality seedlings, seeds can be got germinated in sand beds. In this case, only healthy sprouts taken out from the sand beds are used for sowing in the polythene bags. Shade is provided in the nursery with palm fronds to intercept 70-80% sunlight during the initial two months and progressively reduced later on. The seedlings will be ready for transplanting after 3-4 months. Seedlings over 7-8 months are not good for planting.

As cocoa is a highly cross pollinated crop and shows considerable variation in the yield from plant to plant, it is better that the seedlings are obtained from Government or recognized private nurseries.

Establishment of garden:

Cocoa is planted as a pure crop in forest areas by thinning and regulating the shade. But it can be grown advantageously as a mixed crop in arecanut as well as coconut gardens.

Cocoa under thinned jungle:

Cocoa is grown as a pure crop in forest areas under thinned jungle. In forest areas large trees

are felled and the undergrowth is removed. Where there is not enough shade it is supplemented by planting dadap or *Albizia* sp. well in advance of transplanting cocoa seedlings. However, temporary shade to individual seedlings can be provided in the early years with bamboo cage or palm fronds. Cocoa is planted at a distance of 2.5 to 3.0 m both between and within rows. Transplanting is done in the beginning of monsoon, in May-June under rainfed conditions or at the end of monsoon in September, with the help of irrigation. When it is grown as a pure crop, there will be about 1100 to 1300 plants per hectare.

Cocoa under arecanuts and coconuts:

This is the cropping system which can be adopted advantageously in Kerala, Karnataka and Tamil Nadu. Experimental results indicate that cocoa can be introduced as a profitable intercrop in grown up arecanut and coconut gardens. In arecanut gardens where the spacing is 2.7 m x 2.7 m, cocoa is interplanted in alternate rows at a spacing of 5.4 m x 2.7 m. When cocoa is to be raised as an inter crop in coconut gardens it can be planted 2.7 m apart in a single row. Under the double hedge system, cocoa is planted in two rows in between rows of coconut planted at a normal spacing of 7.5 m x 7.5 m and above adopting a spacing of 2.7 m within the row and 2.5 m between rows. There will be about 550-650 cocoa plants per ha, whether planted in coconut or arecanut gardens. But the number of cocoa plants will be less when interplanted in an irregularly spaced arecanut or coconut garden.

Manuring:

Cocoa plants are to be manured regularly for proper growth and yield. About 10 kg. organic manure in the form of green leaf, compost or cowdung is applied every year per plant in the month of April-May. In addition, fertilizers to supply 100 gm N, 40 gm P₂O₅ and 140 gm K₂O are given for each plant annually. The fertilizers are applied in two equal split doses, one in April-May along with organic manure, and the other in August-September. Although organic manure is given in full dose from the first year of planting, fertilizers are applied only in graded quantities in the initial two years. One year old seedlings are given only 1/3 of the full dose and two year old seedlings 2/3 of the full dose of fertilizers.

Pruning:

Cocoa grows in series of stories, the chupon or vertical growth of the seedlings terminating at the jorquette where four or five fan branches develop. Further chupons develop below the jorquette and continue the vertical growth till another jorquette forms and so on. When the first jorquette develops normally at a height of about 1.5 m the canopy will form a convenient height for harvesting as well as for plant protection operations. It is desirable to confine the tree height to this level by periodical removal of chupons with a sharp knife. Some of the secondary branches which produce intense shade in the centre of the tree are also removed at intervals to permit more sunlight on the trunk and branches. Proper and timely pruning of the trees facilitates easy management of the crop and gives better yield.

Irrigation:

Young cocoa seedlings are irrigated regularly at an interval of 3-4 days during summer months. To save water pot-watering can be resorted to. For higher yields, grown up cocoa plants are also irrigated in the summer season.

Harvesting:

Cocoa starts flowering from the second year onwards. It takes about 5 to 6 months from flower opening to pod ripening stage. There are two main crops in a year, the first from October to January and the second from April to June. But off-season crops are available in other months with one or two pods for harvesting at a time.

All the pods in the tree do not ripen at a time. The ripe pods remain on the tree without damage for about 5 to 7 days. Harvesting is therefore done only at weekly intervals. Ripe pods are separated from the tree with the help of a sharp knife without causing injury to the "cushions" from which they are developed. This is necessary as flowers are produced again from these "cushions". The pods are forced open by hitting on a hard surface or using a wooden mallet. Knife is not used for this purpose as it may cut the beans inside and impair the quality of processed beans. The beans are scooped out from the pod with the help of fingers. A pod will have about 30-40 seeds covered with pulp or mucilage. The harvested pods can be kept as such for a maximum period of 2 to 3 days without spoilage.

Fermentation and drying:

The beans should be fermented to help produce chocolate flavour, reduce bitterness, loose its viability, remove the mucilage coating and enable the cotyledons to expand. For proper fermentation there should be sufficient aeration to the beans, provision for drainage of sweatings and maintenance of temperature in the system. Fermentation is done immediately after collecting the beans from the pods. There are two popular methods of fermentation using trays or boxes, adopted in cocoa growing countries.

Box method: This is the traditional method used for fermentation of beans. Boxes in wide varieties of shapes and sizes are used. The smallest one has the measurements of 60 cm × 60 cm × 60 cm and will hold about 150 kg wet beans. The bottom of the box has a number of holes of 1 cm diameter spaced at about 10 cm apart. Three such boxes are arranged in a row so that beans can be transferred from one box to other. The beans are placed in the top most box and covered with banana leaves or gunny bags. After 2 days, the beans should be uncovered and transferred into the second box, and then to the third box after another 2 days. On the sixth day, fermentation is completed and beans can be taken out for drying.

Tray method: This method is used only for fermenting Forestero cocoa beans. The normal size of the tray is 90 cm length, 60 cm width and 12 cm height with a capacity to hold about 40 kg wet beans. The bottom of the tray is either slotted or drilled to make 1 cm holes on a 4 cm sq. pattern. A minimum of 4 trays are needed for successful fermentation. About 10 to 12 trays can be staked one upon the other with the bottom tray resting on a raised platform. All the trays are filled with beans. The top most tray is covered with banana leaves or sacks. The fermentation is faster here and is completed in about 4 to 5 days. This method is more convenient for large growers as the trays can be easily handled and no mixing is required and the period of fermentation is less.

But these methods are not suitable for small cocoa growers as the number of harvested pods at a time is not enough for proper fermentation. The method which may be adopted by them for fermenting small batches of cocoa beans is as follows:

In this method, a wooden box of at least 50 × 50 × 50 cm size with holes at bottom or a basket of about

this capacity is used. The beans are put in the box and covered with banana leaves. In the case of basket, banana leaves are placed first in it with one side of the leaf edging over the other. After filling the basket with beans, the extending banana leaves are folded over to cover the beans. The box or basket is kept on a raised platform to facilitate the sweatings to drain out. Two days after keeping the beans like this, the temperature of beans rises to about 47°C. For uniform fermentation, the beans are mixed each day. After about 4 to 5 days, the temperature falls down indicating that the fermentation is over.

The fermented beans are dried in the sun by spreading on a mat evenly for about 3 to 5 days. For uniform drying, the beans are heaped and spread 4 times every day. During rainy season artificial drying has to be resorted to. For this electrically operated or firewood used mechanical driers can be employed.

A cheap drier commonly used in most of the cocoa growing countries is the Samoan drier. In this drier the wet fermented beans are spread on drying mats supported by a wooden or metal frame work over a flue made of tar or oil drums. The hot flue creates a convectional current of hot air which rises up through the wet beans. Some opening around the flue are essential to create air current.

Well dried cocoa beans will have only 6 to 7 per cent moisture content which help to retain its quality.

Pests:

Over 1,500 different insects are known to feed on cocoa. However, only about 20 pests have been recorded in India. There are no alarming reports on serious insect attack. The important pests of cocoa are described below:

1. *Stem borer (Zeuzera coffeae)*: Commonly known as red borer of coffee, this is a pest of a number of plants. Young larvae disperse on silk thread 'parachutes' and bore into branches and trunks of cocoa trees resulting in the drying of the aerial portions above the point of attack. Damage is serious especially in young cocoa as the whole plant may be destroyed. For controlling the pest, small branches are pruned off below the points of entry of the larvae and burnt. On trunks and larger branches the pest is controlled by extracting the larvae and plugging the burrows with BHC paste.

2. *Mealy bugs: (Pseudococcus citri and Rastrococcus iceryoides)*:

The pest harbours on young leaves, tender shoots, flower 'cushions' and pods and suck sap from there. It excretes honeydew which attracts ants. Seriously attacked parts lose vigour and show wilting. The pest can be controlled by spraying any contact insecticide with systemic action like dimethoate at concentration of 0.05% (1.6 ml Rogor in one litre of water).

3. *Leaf eating caterpillars*: A wide range of hairy caterpillars and semi-loopers eat away tender leaf and shoot. Although the attack is widely common, the damage is not very serious. Both caterpillars and semi-loopers can be controlled by spraying with 0.1% carbaryl.

4. *Cockchafer beetle (Popillia complanata)*: The larvae (white grubs) of beetles feed on roots, while the adult beetles eat away tender leaves and flowers. The attacked leaves will have a series of irregular holes. The adults often hide in soil and ground litter. The larvae and beetles are controlled by drenching the soil with B.H.C. at 0.15% suspension in water.

5. *Aphids*: Crinkling and premature falling of leaves and wilting of flowers occur due to attack of aphids. Younger plants even wither and all the leaves may fall off. It is not a very serious pest. Control measures are only rarely necessary as natural enemies are abundantly available.

6. *Sap sucking bug*: Apart from mealy bugs, pods are damaged by a sucking insect, probably *Helopeltis* sp. Attacked pods will have black spots. The insect can be controlled by spraying with B.H.C. at 0.25% concentration.

7. *Vertebrates*: A number of vertebrates such as bats, rats, civet cats, squirrels etc. damage ripe pods by making holes and feeding on the sweet mucilage coat of the seeds. Green pods are less attractive but if attacked the beans are also eaten. Poison baiting with zinc phosphide or warfarin, catching them with mechanical traps and clean cultivation etc. are recommended. A good poison bait can be prepared by mixing one part warfarin, eleven parts wheat flour and two parts coconut oil. Harvesting of pods as soon as they become ripe helps to minimise attack by these animals.

Diseases:

In cocoa, the loss of the crop due to diseases is at a high rate. The important diseases noticed in India are given below:

1. *Black pod disease (Phytophthora palmivora)*: It is a fungus disease which affects pods of all stages. The first sign is the development of translucent spot which turns to chocolate brown colour. It blackens and expands rapidly and covers the whole surface of the pod. Infected tissues shrink and become corky in texture. The internal parts also become discoloured in advanced stage of infection. Removal and destruction of all infected pods and spraying with 1% Bordeaux mixture are recommended to control this disease.

2. *Charcoal rot (Botryodiplodia theobromae and Macrophoma sp.)*

The disease occurs only on wounded pods or pods which are under stress. The disease is found more frequently in the dry season. The whole mass of the pod including the beans becomes black in colour. If the infection occurs in the early stages of pod development, the beans may not develop fully. Spraying with 1% Bordeaux mixture is recommended for controlling this disease. Since injury on the pods caused by insect attack is a predisposing factor, a combination spray is given by mixing an insecticide.

3. *Pink disease (Pellicularia salmonicolor)*

This disease is not easily detected until it has penetrated deep into the bark. The first visible symptom is the appearance of salmon pink encrustation of fruiting bodies of the fungus on the bark. Wilting of shoots and shedding of leaves are followed by final drying of the branch. The fungus

remains dormant inside the bark and dead tissues for a long period. The disease is controlled by cutting and destroying the affected branches, painting the cut ends with Bordeaux paste and regularly spraying the trees with 1% Bordeaux mixture.

4. *Cherelle wilt*: The young developing pod is known as "cherelle" and drying up and mummifying of such pods is called 'cherelle wilt'. This is due to the competition for water and nutrients of young pods with the elder developing pods and vegetative growth. This is a natural phenomenon and no control measures are taken against 'cherelle wilt.'

5. *Die-back*: It is caused by physiological as well as pathological factors. The symptom is the progressive drying of the branches from the tip inwards to the jorquette. The leaves turn brown and dries beginning with the youngest. All the leaves are shed until a bare tree remains. The speed of the process is variable but the whole tree often appears unhealthy from the early stage. The cause of the die-back may be environmental, physiological and nutritional disturbances, fungal infection and insect attack as well as interaction of any of these components. The control measures depend upon the cause of die-back.

Economics:

The cost of cultivation of cocoa when grown as an intercrop in one hectare of coconut or arecanut garden is about Rs. 13,000 for the first four years and thereafter Rs. 3,500 per annum. The yield of dry cocoa beans is around 600 kg at the full bearing stage i.e. five years after planting. Since one kg dry cocoa beans fetches about Rs. 35 to Rs. 40 at present, the net income from cocoa cultivation alone is Rs. 19,000 per annum.

GARLIC OIL DEADLY FOR MOSQUITOES.

Garlic oil can kill five species of Indian mosquitoes in the larva stage, it has been discovered by two scientists of the Bhabha Atomic Research centre in Bombay.

Experiments have shown that garlic oil is deadly against Aedes and Culex family of mosquitoes—the types that spread yellow fever and filaria.

The agents responsible for the larvicidal property have been isolated from garlic oil and these agents can be synthesised.

Their report in the *Indian Journal of Experimental Biology* said that natural or synthetic garlic oil was effective against freshly laid eggs of mosquitoes.

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