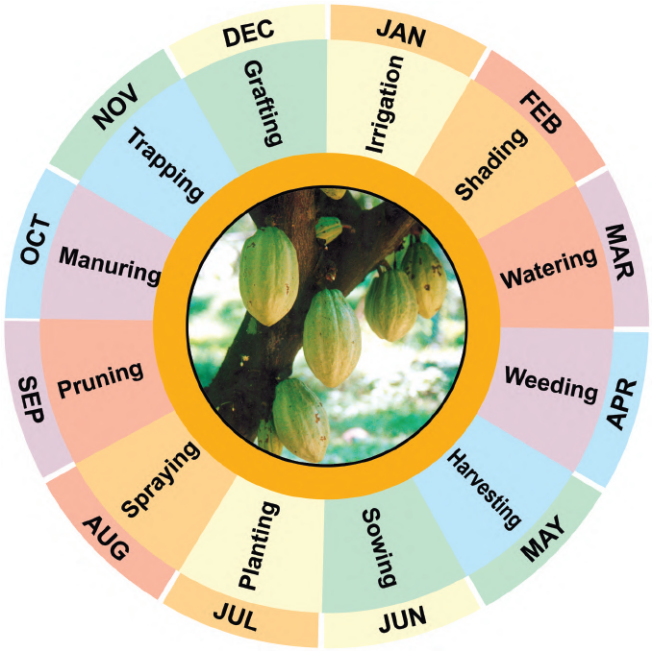
CALENDAR FOR COCOA



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Govt. of India, Ministry of Agriculture
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Technical bulletin
Calendar for Cocoa

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CALENDAR FOR COCOA

Cocoa (*Theobroma cacao* L.) is an important commercial plantation crops of the world. It is a native of 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. Cocoa is a crop of humid tropics and so it was introduced as a mixed crop in India in areas where the environments suit the crop. It is being cultivated in a large scale from 1970 onwards in coconut and arecanut plantations and as an under- storey crop in partially cleared forests with sufficient shade especially in the agroclimatic zone 12 consisting of Western Plains and Ghats.

At present, cocoa is cultivated in an area of 17,800 hectares in India with a production of 10,000 MT. Kerala accounts for 71 percent of the area and 80 percent of the production. Though Andhra Pradesh has the second highest area, Karnataka ranked second in production. It has great potential to be introduced in other states where coconut, arecanut and oil palm are grown. Area expansion programme is being taken up by Directorate of Cashewnut and Cocoa Development (DCCD), Kochi, to meet the demand (30,000 MT) in the Indian chocolate industry. To get sustainable and profitable yield, growers should be aware of the series of operations to be taken up throughout the year in establishing and managing the nursery as well as the plantations. This calendar will give knowledge and insight into the scientific cultivation aspects to new growers, progressive farmers, nursery men and extension officials.

Climatic requirements

Before introducing a crop into a newer area care should be taken to see that the agro climatic conditions are suitable for the crop. Cocoa is a perennial crop, which has to withstand for years over different seasonal variations with good health and yield potential. Though cocoa grows between 20^0N and 20^0S latitude, the main growing areas are situated within 10^0N and 10^0S. Cocoa is grown from sea level upto an elevation of about 500 m. It comes up best upto 300 m 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- 39^0C and optimum temperature is around 25^0C. It cannot be grown in areas where the minimum temperature falls below 10^0C and the annual average temperature is less than 21^0C. Cocoa needs high humidity throughout the year for optimum growth. While establishing plantations these factors should be taken into consideration.

Soil

Cocoa requires deep and well- drained soil for easy penetration of the roots and anchorage. 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. Soil should be of good health and rich in organic constituents. Both nursery and the garden should be nearer to water source to take care of the plants during summer season, as cocoa is sensitive to drought.

CALENDAR OF OPERATIONS FOR COCOA

JANUARY

Nursery	Watering: Daily, Hose/ Sprinkler irrigation
	Weeding
	Removal of lean and lanky seedlings and unsuccessful grafts
	Nurseries which are in operation throughout the year with water facilities and according to the availability of pods, resowing can be done in ungerminated polybags
	Rearranging the polybags
	Regrafting in some unsuccessful rootstocks
	Overhead shade maintenance: With shade net/ thatched leaves/ plaited coconut fronds
Garden	*New garden:* Removal of chupons arising from the rootstocks if grafts were planted and from the seedlings
	Irrigation: Once in five days with 175 litres of water with flood irrigation and 20 liters of water/ day/ tree with drip irrigation
	Shade regulation in the plot
	Old garden: Left over ripe pods of main harvest season and diseased pods if any, should be harvested carefully with a knife without damaging the flower cushions and newly emerged flowers
	Rat and squirrel control: This rain free season is best for rodent control. Poison baiting and rat traps may be installed

FEBRUARY

Nursery	Daily watering- Hose/ Sprinkler
	Weekly weeding
	Rearranging bags
	Shade maintenance
Garden	*Young plantation:* Flood irrigation may be given once in five days, Drip- Daily basis, check the drippers for clogs
	If the existing plaited coconut fronds provided as shade to young seedlings/ grafts decomposed or damaged, replace with new one
	Weeding: In young plantations after weeding the cut weeds and palm leaves can be spread over the barren soil in between cocoa rows which will protect against hot sun, keep it moist and cool and enrich the organic content of the soil

MARCH

Nursery	Daily watering
	Regular supervision of shade net position Tie the nets tightly over the pipes and pillars without bending Cover the entire nursery area to allow filtered sunlight
Garden	Mulching: Provide green leaves/ coir compost/ 5 kg FYM which will conserve the moisture in the young plantation during summer and enrich the physical properties of the soil
	Irrigation: Flood- Once in five days, Drip- Daily
	Shade management with intercropped banana and other shade trees in the borders to reduce the effect of sun
	Pruning: Removal of chupons arising from the main stem
	Plant protection (Pests & Diseases)

Canker (*Phytophthora 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.

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 plant 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.

Canker

Charcoal Pod Rot

Preparation of 10% Bordeaux paste

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

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

It is the most important insect pest of cocoa in India, which occurs during summer season. 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 at the loci of the colonies with Fenthion (Lebaycid) 50 ml in 100 litres of water or Dimethoate (Rogar) 160 ml in 100 litres of water is the best method of management. If recurrence of the pest is noticed, a second round of spraying is recommended after an interval of 30 days.

Tea mosquitoe bugs *(Helopeltis antonii):*

If cashew plantations are nearer to the cocoa garden tea mosquito bugs appears irrespective of seasons. These bugs usually damage the pods. Infested pods develop circular water soaked spots around the feeding punctures. These punctures subsequently turn pitch black in color. Deformation of pods occur because of multiple feeding injuries.

Eventhough 50 insect pests are reported from India, most of the insects have their own natural enemies and so chemical sprays are recommended in severe conditions only.

Mealy Bugs

Tea Mosquito Bugs

APRIL

Nursery	Daily watering/ Sprinkler
Garden	Weeding: In young cocoa plantations weeding may be done
	Forking, basin opening Fertilizer application: First dose at the end of April in the irrigated garden
	Irrigation: Irrigate sufficiently after fertilizer application for efficient absorption

Fertilizer schedule for cocoa

An annual application of 100g N, 40g P_2O_5 and 140g K_2O per tree in two equal splits is recommended. The fertilizer is applied in two splits, the first dose in April- May and the second dose in September- October i.e. pre and post monsoon applications.

Method of application

Fertilizer may be applied uniformly around the base of the tree up to a radius of 30 cm during the first year, forked and incorporated into the soil. For grown up plants the best method is to rake and mix the fertilizers with soil in shallow basins of around 75 cm. This radius may be increased gradually upto 150 cm after third year. Care should be taken not to spill the inorganic fertilizers on the trunk, branches or leaves of young trees in order to avoid burning.

Fertilizer	I year	II year	III year onwards
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

MAY

Nursery	Establishment of Nursery: As the main harvest season starts pods are now available for sowing
	Daily watering/ Sprinkler
Garden	*New garden:* Selection of site and laying out for new plantation
	Pitting: Pits of 60 cm^3 should be taken 2- 3 weeks before planting to ward off the field heat. While digging top and bottom soils should be heaped separately
	Pit filling: Pit should be half filled with FYM (15- 20 kg) and top soil one week before planting. While planting fill with bottom soil
	Old garden: As the main harvest season starts from end of May ripe pods should be harvested carefully with a knife without damaging the flower cushions
	Manuring: If first dose of fertilizers were not given during April, this month it can be given in irrigated cocoa gardens
	Plant protection: Before the onset of south west monsoon dried twigs and diseased pods should be removed. 1% Bordeaux mixture may be sprayed as a prophylactic measure to avoid *Phytophthora* related problems in high rainfall areas

ESTABLISHMENT OF NURSERY

Selection of mother trees and pods

Before establishing a nursery the criteria for selection of mother trees and pods should be considered for quality planting material production.

- Trees bearing lot of fruits with biggest pods can be selected (70- 100 pods/ tree/ year). The high yielding nature of the tree and quality of the seeds enter the new plant, which will also yield many big pods.
- Trees of Forastero type (green- immature, yellow- ripe) having medium to large pods of not less than 350 g weight, smooth or shallow furrows on the surface without prominent constriction at the neck can be selected.
- Husk thickness of pods to be more than 1 cm.
- Pod value (number of pods required to produce 1 kg beans) to be not more than 12.
- Number of beans per pod should be more than 35.
- The best seeds for sowing are those from the middle of the pod.
- Bean dry weight should be more than 1 gram.

TYPES OF NURSERY

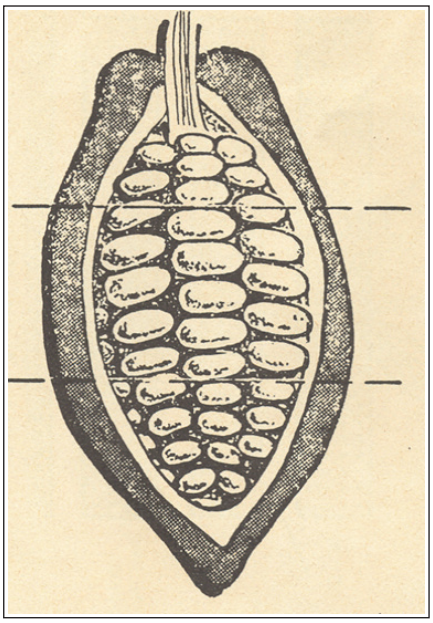
Raised Bed Nursery

- Sowing cocoa seeds in raised beds is generally said to be good and followed by most of the farmers for their own planting material production.
- Small, plain and flat plot with adequate sun light (25- 50%), rich soil and a water source should be selected.
- Soil should be tilled fairly deeply and lumps of earth should be broken up to get a fine tilth.
- Beds of 90- 120 cm width and of any length are preferable.
- A path of 60 cm as walking space between one bed and the next to monitor the nursery is needed.
- While sowing enough space between furrows and seeds should be given which will enhance better growth before transplanting to main field (upto 4 to 6 months it can be kept in the nursery bed).
- Young cocoa seedlings are very delicate and should be protected from the sun by putting them under shade net at 180 cm high above each bed or by covering with palm fronds.
- Sorting of healthy seedlings is possible in the nursery bed. Late germinated seedlings won't grow well or die and they can be sorted out.

Polybag Nursery

- To get better root and shoot growth and to make the planting easy sowing seeds in polythene bags or small baskets are being followed.
- Polybags of 6”x 9” size, 250 gauge either black or white colour is preferred which is filled with rooting mixture 2:1:1 Soil: Sand: FYM.
- Bamboo baskets or bags made up of locally available plant materials which are biodegradable are being used in some cocoa growing countries.
- Big poly bags of 30 cm length and 20 cm width can also be used if the seedlings are to be kept in the nursery for longer periods.
- Poly bags should be arranged in rows leaving a little path between the rows for monitoring.
- Shade nets or covering by thatches is needed.
- Young seedlings needs lots of water and should be irrigated gently every day in summer and once in alternate days in other seasons.
- Proper drainage should be provided during rainy season to prevent stagnation of water and rotting of seedlings.

Mother tree (Forastero)



Extract middle beanss

SOWING

- Extracting of bold, larger beans from well- matured, big seed pods of ideal plants is necessary.
- Sowing of seeds should be done immediately after removal from the pod. Harvested pods should not be kept more than one week as the beans may loose their viability.
- Rubbing of the beans carefully with dry sand or wood ash to remove the mucilage is required.
- Seeds should be kept horizontally or vertically with hilum end down and just covered with sand.
- Pushing of seeds deeply into the bed or polybag should be avoided because lack of air may affect seed germination.
- Seeds start germination in about a week and will continue for another one week.
- Percentage of germination will be around 90.
- Cocoa seeds will germinate at any time of the year with adequate irrigation. Matured pods will be available during May month and so sowing can be started. Sowing should be completed before the onset of monsoon, as much rains may affect the germination.
- May sown seedlings will be readily available for planting during September- October, the post monsoon season in the high rainfall zones like Kerala and Karnataka.
- For transplanting during May, seeds should be sown during December- January.

GENERAL PREFERENCES

- It is desirable to collect seeds from biclonal or polyclonal seed gardens involving superior self- incompatible parents to ensure genetic superiority of the planting materials.
- If seeds cannot be procured from such seed gardens then the criteria for mother plants should be strictly followed.
- Viability of the bean can be extended for some more days by storing freshly extracted seeds in moist charcoal and packed in poly bags.

Mixing seeds with sand

Sowing

Raised bed nursery

Polybag nursery

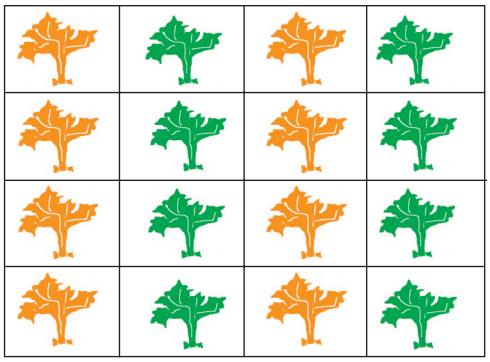
CLONAL ORCHARDS AND PRODUCTION OF F1 HYBRIDS

The purpose of clonal orchard is to produce seeds of known parentage and proven performance in terms of high yield. The compatibility reactions shown by cocoa varieties are different to each other. Though seed is the cheapest and most convenient planting material in cocoa, open pollination resulted in larger variability. Therefore, based on the performance of earlier progeny trials the parents with best combining ability from the seed gardens were selected.

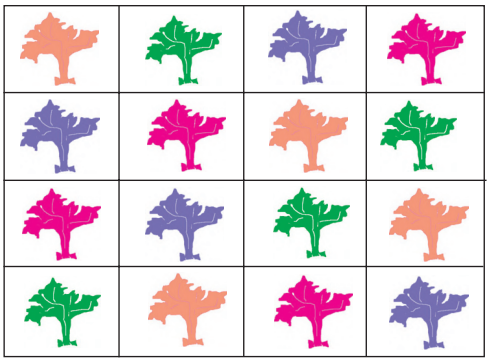
These identified parents which are self incompatible but cross compatible are multiplied vegetatively and planted in the properly designed clonal gardens. The self- incompatible female parent resulted in F1 hybrids through natural cross- pollination or desirable crosses through artificial hand pollination (bi clonal orchards). In a poly clonal orchard pollen parent is planted in a ratio of one to five female parent trees and seed is collected only from the self- incompatible parent. It is also assembled with multiple clones.

These well designed clonal orchards are being maintained by CPCRI, Regional Station, Vittal and CPCRI, Research Centre, Kidu exclusively to prevent undesirable crosses and to produce genetically pure planting materials which is not at all possible for any commercial planter to produce. KAU also has clonal orchards for F1 hybrid seed production.

Bi Clonal Orchard	Poly Clonal Orchard
I-56 & NC-42/ 94	I-14
ICS-6 & SCA-6	I-56
I-56 & III-105	III-105
I-14 & NC-42/ 94	NC-42/ 94
I-14 & I-56	
I-14 & IV-20	



Bi clonal orchard



Poly clonal orchard

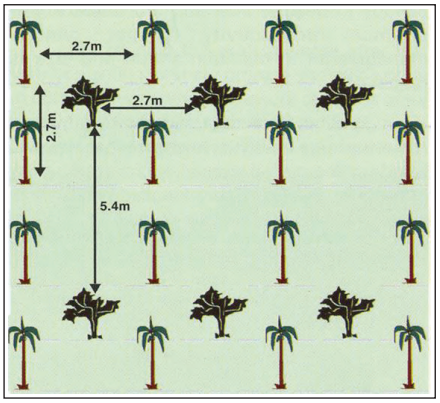
ESTABLISHMENT OF GARDEN

Site selection

When new planting is to be undertaken, as far as possible select coconut and arecanut plantation, which let in more sunlight as well as provide shade during summer. Soil should be permeable, deep and well structured with humus for the spread and penetration of tap root as well as branching roots. Never plant cocoa trees in hard layered soils with lot of stones.

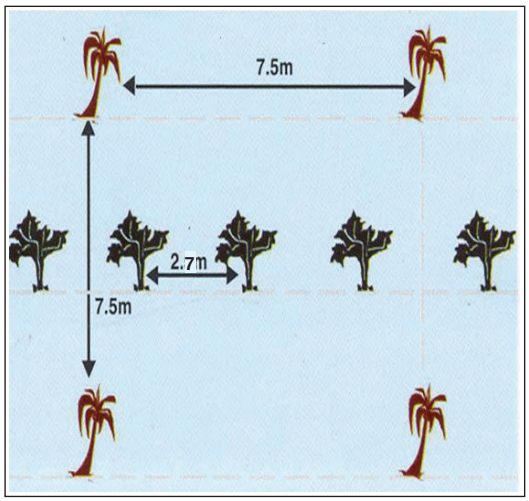
Spacing

In Arecanut plantation of 2.7 m x 2.7 m spacing, cocoa can be planted in the centre of four arecanut palms at 2.7 m x 5.4 m spacing by leaving an areca row in between. In coconut plantation of 7.5 m x 7.5 m spacing, cocoa may be planted in the centre of two rows of coconut as a single hedge system. The plant to plant space between cocoa plants within a row may be 2.7 m. When the spacing of coconut is more two rows of cocoa can be accommodated between two rows of coconut as a double hedge system and the spacing of cocoa may be 2.5 to 2.7 m. However it is advised to leave 3 m from the base of coconut palm in order to avoid competition for water and nutrients between the plants.

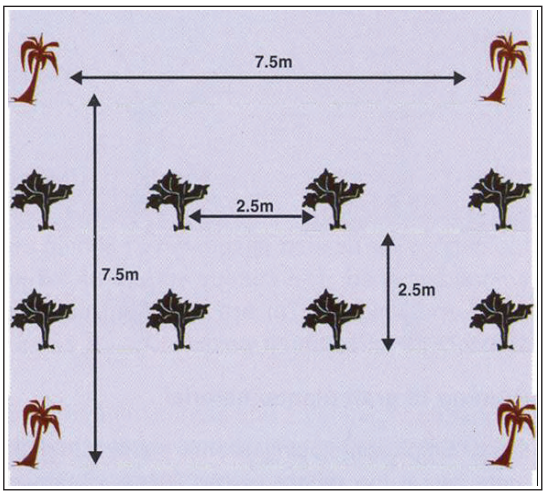


Cocoa under Arecanut

Young Planatation



Cocoa under Coconut - Single Hedge System



Double Hedge System

JUNE

Nursery	Watering: Depend on intensity of rain
	Weeding: Regular removal of weeds
	Monitoring for incidence of any diseases especially die back of seedlings
	Provide sufficient drainage and channels should be cleared
Garden	*New garden:* Take up transplanting in the beginning of south west monsoon or the first week of June in low rainfall areas which is the best season
	Mulching: After planting, pit should be mulched with green leaves
	Staking: Strong small sticks should be used as stakes for tying the young seedlings
	Shading: Cover the seedlings with plaited coconut leaves and grow shade crops like banana in the interspaces
	Life Irrigation should be given immediately after planting if rains are not there
	Sunhemp (green manure crop) seeds may also be sown in the interspaces as a soil reclamation measure and to avoid weed growth especially in the gardens without much overhead shade (@ 20 kg/ acre)
	Both in young and old gardens: Remove drip lines, roll back and keep safely to use during post monsoon season. This will prevent the pipes/ tubes from soiling, mudding and clogging
	Clean the channels and improve the drainage facilities
	Pruning: Removal of chupons arising from the main stem
	Old garden: Ripe pods should be harvested carefully with a knife without damaging the flower cushions. Weekly harvest is preferred
	Fertilizer: In unirrigated cocoa gardens manuring can be done at the onset of monsoon when the soil is wet for easy incorporation and absorption

TRANSPLANTING

- Only vigorous seedlings are to be used based on height and stem girth.
- When seedlings are grown under heavy shade hardening for ten days by exposing to higher sun light may be necessary before transplanting.
- Watering of the nursery beds should be done before lifting seedlings for transplanting to avoid breakage of roots and should be taken along with little earth around the roots.
- If raised in polythene bags, the poly cover should be removed and the seedlings are planted with ball of earth into the pit.
- The seedling/ graft/ budded plant should be planted in the centre of the pit, not too deep.
- We can place the seedlings raised in wire baskets as such in the pits dug in the plantation, which will degrade in the soil in due course.
- While planting grafts polythene strip tied over graft joint should be removed and the joint should be above the soil.
- The planting material may be of 4- 6 month old seedling or grafted or budded plant.
- Avoid planting seedlings with twisted or damaged tap root or pot bound plants.



Pitting and Planting



Mulching **Drip pipes rolled back** **Shading**

JULY

Nursery	Intermittent removal of weeds is necessary otherwise all nourishment will be taken away by the weed plants
	Mechanical killing of insects like grass hoppers and caterpillars may be done. Burning of diseased plants is advisable
	Removal of shade nets during rainy season
	Improve the drainage facilities
Garden	*New garden:* Removal of emerging shoots from the rootstock in field planted grafts. Replace the weak, dried seedlings by gap filling
	Soil bunding at the base and anchoring of young seedlings to be done to avoid fall and damage during rainy season
	In young plantations weeding should be done frequently (4 times a year). Grown up gardens will enhance shade which suppress weed growth and so weeding can be done twice a year. Care should be taken not to damage trunk, branches and roots of young plants.
	Old garden: Ensure drainage facilities
	Plant protection
	Harvesting continued

Harvesting

Grafted tree starts flowering from second year onwards. In the initial years cherelles may be removed and pods of later years may be harvested. There are two harvests each year in cocoa plantations, one at the beginning and another at the end of the rainy season. Cocoa pods take 150- 170 days from pollination to attain the harvest stage. The stage of maturity is visible from the change of colour of green pods to yellow and red pods to orange. They remain without damage upto a maximum of about one month on the tree and so the harvest interval may be of 15 days. But at the incidence of BPD and attack of rodents harvesting intervals should be shorter. Harvesting should be done with a sharp knife without damaging the cushions. Never pick the pods by pulling them off. In Karnataka the peak harvest season is from May to September and staggered harvest during October to December. The harvested pods can be kept upto four days which, will enhance the prefermentation activity inside the pods and helps to get good quality beans. Companies will procure the produce as pods or as beans. The harvested pods will be broken by hitting against a hard surface or with a wooden mallet, extract the beans without placenta and can be supplied or kept for fermentation if on farm processing involved. Husks can be composted.

Removal of chupons

Harvesting

Black pod disease (BPD) (*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 during 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 percent 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.

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.

Black pod disease

White thread blight

Vascular Streak Dieback (VSD) (*Oncobasidium theobromae*)

It is 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 and the other leaves on the shoot show similar symptoms. When the infected shoot is split lengthwise there is always a characteristic brown streaking. The disease can be controlled by disposing diseased branches and regular pruning of chupons on the trunk. Cocoa nurseries should not be located near the diseased area. Avoid getting seedlings from diseased tracts. Kerala Agriculture University has developed some VSD resistant and high yielding varieties CCRP-1 to CCRP-7.

Nursery Diseases

Seedling dieback/ seedling blight caused by *Phytophthora palmivora* Butl. is very common in the cocoa nurseries of Kerala, Karnataka and Tamil Nadu during rainy season. Younger seedlings are more susceptible to the disease and severe infections observed in grafted and budded plants also. It initiates from the collar region, cotyledonary stalk or leaves as dark brown to black discoloration. It spreads to the entire stem causing wilting, defoliation and ultimate death of the seedlings.

Foliar infection caused by *Colletotrichum gloeosporioides* Penz. is also common in almost all nurseries. Seedlings with infection look very unhealthy due to leaf blight, crinkling of leaves and stunted growth. White thread blight caused by *Marasmius scandens* Massee leading to dieback of six month old seedlings has been reported as a problem in nurseries with high humidity, poor aeration and low availability of sunlight. Zinc deficiency symptoms are also reported.

Removal and destruction of infected seedlings from the nursery are very important to check the secondary spread of the disease. The disease incidence can be considerably reduced by improving the drainage facilities in the nursery and by providing proper shade. Drenching the seedlings with Bordeaux mixture (1%) or copper oxychloride (0.2%) just before the onset of monsoon and thereafter at frequent intervals will control seedling dieback.

Vascular Streak Dieback

Seedling blight

AUGUST

Nursery	Weeding and supervision for any disease incidence
	Drenching the seedlings depends on severity of disease incidence
	Resowing in ungerminated polybags when rains subsided
	Watering depends on intensity of rain
	Ensure proper drainage in the nursery
Garden	*New garden:* Removal of emerging shoots from the main stem
	Soil bunding and anchoring of young seedlings
	Supervise for the condition of drainage channels. Channels blocked with muddy soil and plant wastes should be cleaned
	Old garden: Improve the sanitation in the garden by removing fallen rotten leaves, over ripe pods, broken branches etc.
	Slight pruning may be done to ensure sunlight and aeration in the garden
	Plant protection
	Harvesting continued

Aphids *(Toxoptera aurantii* Bde F.*)*

They colonise on the underside of tender leaves, succulent stem, flower buds and small cherelles. Heavy infestation may occur after rainy season which brings about premature shedding of flowers and curling of leaves. Spraying with Dimethoate (Rogar) at 16 ml in 10 litres of water is suggested.

Aphid

Leaf eating caterpillar

Cherelle wilt

Leaf eating caterpillars

They include bag worms, caterpillars of *Lympantria* 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.

Cherelle wilt

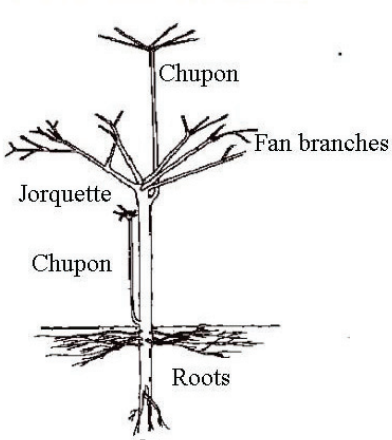
The shriveling and mummifying of some young fruits are a familiar sight in all cocoa gardens. In the early stages the fruits lose their lustre and in four to seven days they shrivel. The fruits may wilt but do not abscise. In cocoa it is considered as a natural thinning process during different stages of pod development. Many other factors like insects, diseases, nutrient competition and over production may also associated with this problem. Hence, remedial measures will depend upon the nature of the causative factors involved.

TRAINING AND PRUNING IN YOUNG PLANTS

Formation Pruning

The plants start to develop the first jorquette when they are 14 months old. 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 to get optimum productivity. It is desirable to restrict the jorquetting height to 1- 1.5 m under the intercropping situations prevalent in India. However some plants in a plantation may jorquette at lower levels.

The jorquetting height can be increased by nipping the fan branches close to the jorquette immediately after development. This will facilitate development of chupons just below the cut portion and from among the many chupons allow the most vigorous one to grow and destroy all others. This chupon will jorquette at the desired height. 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. It also involved removal of number of unwanted chupons arising from the main stem. Some cocoa seedlings in a plantation may produce two stems. In such cases also, retain the most vigourous one and remove the other.



Tree architecture

SEPTEMBER

Nursery	Weeding and supervision for any disease incidence
	Watering depends on continuity of rain
	Grafting in May sown 4 months old rootstocks
	As availability of good pods are more during this main harvest season and rains are little bit subsided, sowing can be taken up
	Rootstock preparation to ensure grafting during December, followed by planting during May
	Follow the mother tree, pod selection criteria and sowing procedures for seedling preparation
	Polybag nursery is preferred for raising rootstocks
Garden	*New garden:* Planting at the end of monsoon in high rainfall areas
	Soil bunding and anchoring of young seedlings, mulching and shading
	Before sunhemp plants start flowering, cut and incorporate in the basins
	Regular removal of chupons
	Training in young plants
	Old garden: Forking and fertilizer application (second dose)
	Pruning in matured trees
	Plant protection
	Harvesting continued

PRUNING IN MATURE TREES

Sanitary pruning

Diseased or unwanted branches with vascular die back and water shoots are removed to maintain the health and vigour of the tree. It include removing all unnecessary chupons, dead branches, epiphytes, climbing plants, ant nests, rodent- damaged and over ripe pods.

Structural pruning

It is being done to shape the canopy to desired size and architecture.

Pruning of seedlings

For pruning of 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 4.0 m and height 2.7 m are the ideal canopy architecture for optimum yield.

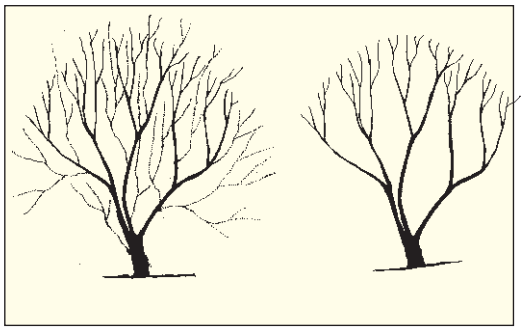
Pruning of grafted plants

Emphasis is being given to plant graft materials in the recent years. This is obtained from soft wood grafting method using high yielding cocoa clones. For pruning of 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 3.8 m to 4.2 m spread and 2.7 m 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 August- September. 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- 20 m^2.

- Prune the trees to the extent of retaining 20- 30 leaves/ developing pod.
- Chupons must be removed very often.
- While pruning care should be taken to give minimal disturbance to the plant with flowers, cherelles and pods.
- In all pruning methodologies when removing large branches ensure that exposed wood surface is not damaged. To prevent the entry of fungi or insects apply fungicides (Bordeaux paste) immediately after the pruning.
- Generally pruning is done after harvesting.

Pruning in seedling



Pruning in grafted plant

OCTOBER

Nursery	Weeding and supervision for any disease incidence
	Watering depends on intensity of rain
	Grafting in May sown rootstocks
Garden	*New garden:* Pruning
	Soil bunding and anchoring of young seedlings
	Forking and fertilizer application (second dose if not applied during September)
	Banana suckers can be planted during this season in a new garden to ensure shading for young seedlings to be planted during forthcoming May
	Old garden: Plant protection
	Scything and weeding
	Harvesting continued

NOVEMBER

Nursery	Weeding
	Watering depends on intensity of rain
	Plant protection
Garden	Installation of drip lines and tubes
	Irrigation once in a week
	Soil bunding and anchoring of young seedlings
	Mulching may be done in young cocoa plantations with cocoa or coconut husk/ fallen cocoa leaves/ pruned twigs
	Old garden: Plant protection
	Harvest
	Rat and squirrel control
	Weeding in plantation

RODENTS CONTROL

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 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.

Squirrel damage

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 (October- November) when, the alternate foods such as paddy, cashew apples, mangoes and jackfruits are not available. Timely harvest of the pods will help in increasing the efficiency of poison baiting as well as trapping.

Rat damage

ZINC DEFICIENCY

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 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.

Zn deficiency

DECEMBER

Nursery	Weeding
	Daily watering
	Grafting in September sown rootstocks
	Shade net covering in the nursery
Garden	Irrigation once a week
	Drip irrigation- Daily basis
	Chupons removal
	Plant protection
	Weeding

Nursery watering

Drip irrigation

VEGETATIVE PROPAGATION

Grafting and budding are being followed in multiplication of cocoa. As the seedling progenies showed wider genetic variability, to maintain true to types, asexual or vegetative propagation is followed. It also ensures multiplication of identified high yielding clones in large quantities. Soft wood grafting method is standardized in cocoa at CPCRI, Regional Station, Vittal with 85% success rate. For the grafting technique to be successful stock and scion compatibility is very important which exists in cocoa. Budded plants are being supplied by KAU.

Grafting Technique

- 3 to 4 months old seedlings raised in polybags can be used as root stocks for grafting.
- Scion stick of 12- 15 cm length with 2- 3 buds from desirable high yielders can be collected.

- Scion sticks of chupons can be taken if seedling like architecture and lesser pruning is preferred. Whereas for early evaluation works and large- scale commercial production fan branches are preferred.
- Root stock stem and scion stick should be of same thickness and physiological age.

Give a horizontal cut at the upper portion of the rootstock with a grafting knife.

Make a vertical slit of 2 to 3 cm down (cleft) on the decapitated root stock.

Scion sticks being removed off the leaves should be given a 'V'shaped slanting cut of 2- 3 cm length (wedge) at the bottom.

Grafting is done by inserting scion into the stock i.e. wedge into the cleft

Tie tightly with a polythene tape of 1.5 cm width over the joint.

Cover with polythene pouch so that the graft joint won't dry up.

Perfect graft joint will occur in one month

Successful graft will be ready in 5- 6 months for field planting.

Points to Ponder

- The polythene pouch can be removed after 15- 20 days of successful graft joint or bud take.
- Polythene strip tied over the joint should be removed after 2 months.
- The emerging shoots from the rootstocks should be removed.

- October to December season will be the best for grafting and all other seasons are preferred with sufficient irrigation.
- Grafts will start yielding from the second year onwards.
- Grafting pest and disease resistant clones on susceptible rootstock is an added advantage of this technique and old, unproductive plants can be rejuvenated through this technique by top working. Conservation of multiple varieties on a single tree is also possible.
- High yielding clones I-56, II-67, III-105, NC-42/94 and NC-45/53 are being multiplied by this soft wood grafting method and nearly 50,000 grafts/ year are supplied to farmers and developmental agencies by CPCRI.
- When budded or grafted plants are used select two or more clones for planting, as the use of single clone may not yield due to the existence of self- incompatibility in cocoa.

HIGH YIELDING COCOA VARIETIES

Four hybrids and one clone were released from CPCRI, which are high yielding and having good dry bean characteristics. They can be grown in arecanut, coconut and oil palm gardens of Kerala, Karnataka, Tamil Nadu, Andhra, Maharashtra and Goa. They are being multiplied as grafts and supplied to farmers, planters, agri/ horti departments and private organizations.

VTLCH-1 (Vittal Cocoa Hybrid-1)

Cross- I-56 x II-67
Vigorous, early, heavy bearer
50 yellow pods/ tree/ year
Dry bean yield/ tree/ year- 1.48 kg
Single dry bean weight- 1.00 g
Yield/ Ha- 1014 kg
Fat content- 53.6%
Shelling- 13%

VTLCH-2 (Vittal Cocoa Hybrid-2)

Cross- ICS-6 x SCA-6
Early, heavy bearer, BPD tolerant
70 yellow pods/ tree/ year
Dry bean yield/ tree/ year- 1.15 kg
Single dry bean weight- 1.15 g
Yield/ Ha- 800 kg
Fat content- 54%
Shelling- 11%

VTLCH-3 (Vittal Cocoa Hybrid-3)

Cross- II-67 x NC-29/66
Early, heavy bearer, suitable for water limited conditions
45 yellow pods/ tree/ year
Dry bean yield/ tree/ year- 1.45 kg
Single dry bean weight- 1.07 g
Yield/ Ha- 993 kg
Shelling- 13%
Stomatal resistance (s/cm)- 2.42

VTLCH-4 (Vittal Cocoa Hybrid-4)

Cross- II-67 x NC-42/94
Early, heavy bearer, suitable for water limited conditions
40 red pods/ tree/ year
Dry bean yield/ tree/ year- 1.25 kg
Single dry bean weight- 1.01 g
Yield/ Ha- 856 kg
Shelling- 12%
Stomatal resistance (s/cm)- 2.41

VTLCC-1 (Vittal Cocoa Clone-1)

Nigerian selection
Early, heavy bearer, both self and cross compatible
75 yellow pods/ tree/ year
Dry bean yield/ tree/ year- 1.33 kg
Single dry bean weight- 1.05 g
Yield/ Ha- 911 kg
Fat content- 52.5%
Shelling- 12%

Marketing of cocoa pods and beans

Systematic procurement, processing and marketing is carried out by the consuming industries such as Cadbury, Nestle and Campco through their own collection centres in all the cocoa producing areas. Farmers usually sell their pods/ beans at such centres.

COST OF PRODUCTION OF GRAFTS

For 50,000 grafts

S.No.	Item	Rate (Rs.)	Quantity	Cost (Rs.)
1	Shade net- 75% (sq.m)	12.00	3000	36,000
2	Farm Yard Manure (MT)	1000	50	50,000
3	Polythene bags 6x9" size 250 gauge with 9 punches (Kg)	70	350	24,500
4	Pepsi covers (15 x 6 cm) (Kg)	60	350	21,000
5	Preparation of potting mixture (2:1:1:Soil:Sand:FYM) collection of sand, sieving, mixing, filling, arranging in beds and sowing (Bag)	1.25	50,000	62,500
6	Grafting (collection of scion, rearranging grafted seedlings and left over rootstocks)	1.10	50,000	55,000
7	Labour charges for watering and maintenance of nursery 2 persons/ day	70	1 year	50,000
			Total	**2,99,000**
	Sale of graft	12	50,000	**6,00,000**

Persons to be contacted for planting materials and details

1. Head, CPCRI, Regional Station, Vittal- 574 243, Karnataka
2. Professor & Head, KAU-Cadbury Cocoa project, College of Horticulure, Vellanikkara, Thrissur- 680 656, Kerala.
3. Director, Directorate of Cashewnut and Cocoa Development, Kochi- 682 011, Kerala.

Estimated cost of cultivatio for cocoa when grown as mixed crop in arecanut garden (Rs per Ha)

	Particulars	(Rs./Ha)
1.	Establishment cost during pre- bearing stage (3 years)	50,000
2.	Cost of drip system	15,000
3.	Total establishment cost including drip system	65,000
4.	Annuity value for establishment cost	4,800
5.	Annual fixed cost of drip irrigation system	3,000
6.	Labour charges for annual maintenance	13,200
7.	Input charges for annual maintenance	10,000
8.	Total annual maintenance cost during bearing stage	23,200
9.	**Total cost of cultivation per year with annuity value during bearing stage**	**28,000**
10.	**Total cost of cultivation per year with annuity value during bearing stage with fixed cost for drip irrigation**	**31,225**
Prices as per 2006		
Annual Production of Cocoa :		**650- 1300 Kg/Ha**

Manufacturers

1. Managing Director, NESTLE INDIA LTD, DLF Centre, Sansad Marg, New Delhi-110 001.
2. Managing Direcor, CADBURY INDIA LTD, 19 B, Desai Road, Mumbai- 400 026.
3. Managing Direcor, CAMPCO LTD, P.B.No.223, 'Varanashi Towers', Mission Street, Mangalore- 575 001, Karnataka.
4. General Manager, CORP. Affairs, HINDUSTAN LEVER LTD, 203, Mohta Building 4, Bhikaji Cama Place, New Delhi.
5. General Manager, Tech., BRITANNIA INDUSTRIES LTD, 33, Lawrence Road, Delhi-110 035.

COCOA DEVELOPMENTAL STAGES