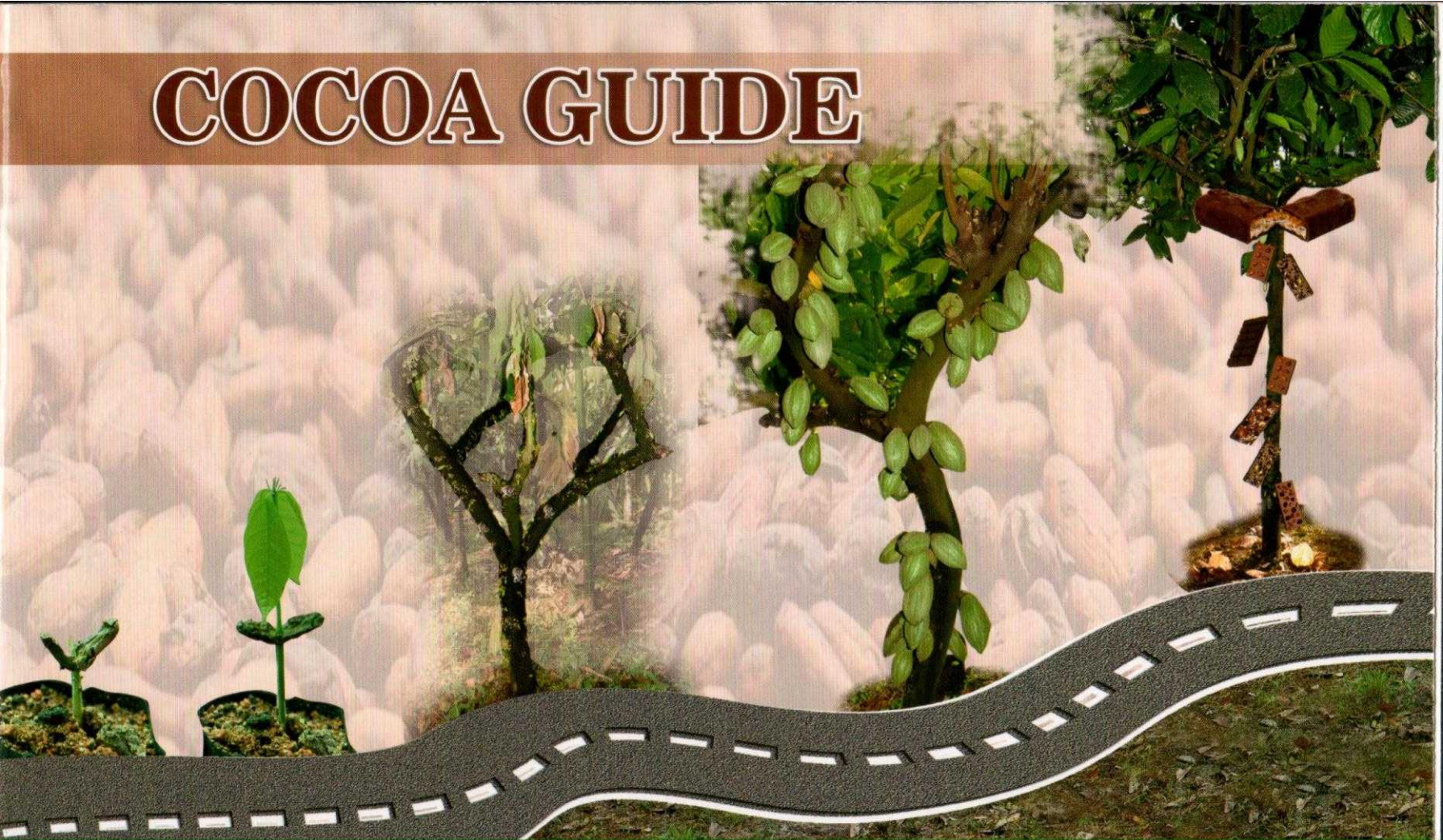


# COCOA GUIDE



**ICAR - Central Plantation Crops Research Institute - CPCRI**  
Kasaragod, Kerala- 671 124





# COCOA GUIDE



State	Area (ha)	Production (MT)
Andhra Pradesh	24,130	1650
Karnataka	13,600	18,920
Kerala	15,894	
Tamil Nadu	39,205	
Tunisia	82,940	



ICAR- Central Plantation Crops Research Institute  
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Technical Bulletin No. 134  
Cocoa Guide

# COCOA GUIDE

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## COCOA GUIDE

Cocoa (*Theobroma cacao* L.) is an important beverage crop of the world and commercially grown as an intercrop in coconut and arecanut gardens in India. It is native to Amazon region of South America and consumed as a bitter energy drink 'xocoatl' by Mayans and Aztecs and later with addition of milk and sugar it became chocolate, which is the favourite food of the millions. The main cocoa producing countries are Ivory Coast, Ghana, Indonesia, Brazil, Nigeria, Cameroon and Malaysia. Cocoa is a crop of humid tropics requires shade and water, and so it was introduced in the foot hills of Western ghats and plains as an intercrop in coconut and arecanut.

At present, cocoa is cultivated in an area of 82,940 hectares in India with a production of 18,920 tonnes covering states of Kerala, Karnataka, Tamil Nadu and Andhra Pradesh. National Horticulture Mission identified cocoa as a potential crop to meet out both domestic demand and export earnings and encouraged area expansion in traditional and non-traditional areas under arecanut, coconut and oil palm gardens. To get sustainable yield and to increase the productivity to 600 kg/ha quality planting material supply with elite clones and hybrids, improved production systems, canopy and resource management, seasonal protection measures, farm level processing and streamlined marketing facilities are important. This farm guide will give an overview on scientific cultivation and processing methods of cocoa to new growers, progressive farmers, nursery men and extension officials.

State	Area (ha)	Production (MT)	Productivity kg/ ha (Dry beans)
Andhra Pradesh	24,156	7700	800
Karnataka	13,685	2420	450
Kerala	15,894	7150	750
Tamil Nadu	29,205	1650	320
<b>Total</b>	<b>82,940</b>	<b>18,920</b>	<b>580</b>

**Directorate of Cashewnut and Cocoa Development- DCCD- Kochi (2016-2017)**



## Climatic requirements

Cocoa is a perennial crop, which has to withstand weather vagaries in a crop cycle during its different growth stages and, the basic requirement of suitable agro climatic conditions are to be considered while introducing this crop to new area. Though cocoa grows between 20°N and 20°S latitude, the main growing areas are situated within 10°N and 10°S. Cocoa is grown at an elevation of 500 m from sea level, while it comes up best upto 300 m. Ideally, cocoa requires a minimum of 90-100 mm rainfall per month with an annual precipitation of 1500-2000 mm. Supplementary irrigation is required during six months of rainless period in India. 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.

## Soil

Cocoa requires deep and well-drained soil for easy penetration of roots and better anchorage and should retain moisture during dry season and permit movement of air. 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. The ideal soil for cocoa should have 1.5 m depth, 3.5% organic matter, >9 C:N ratio, >12 me/100 g soil base exchange capacity and >35% base saturation. Cocoa does not come up in coastal sandy soils, where coconut flourishes.

## Shade

Cocoa whose natural environment is the lower storeys of the forest requires shade when young and also to a lesser extent when grown up. Young cocoa plants grow best with 50% sunlight. It grows very well in the partially shaded conditions prevailing in the arecanut and coconut gardens in our country. As the tree matures, its shade requirements are reduced. Both temporary and permanent shade trees are being used as shade for cocoa in agro forestry systems.






## Land suitability criteria for cocoa cultivation

Land use requirement			Rating			
Land quality	Soil site characteristic	Unit	Highly suitable S1	Moderately suitable S2	Marginally suitable S3	Not suitable N
Temperature regime	Mean monthly temperature	°C	15-32	32-40, 10-15	>40, <10	-
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Moderate to imperfect	Imperfectly, excessively drained
Nutrient availability	Organic matter in root zone	%	>2	1-2	0.5-1	<0.5
Nutrient retention	Texture	Class	CL, L, SL, SCL	C (mixed mineralogy)	LS	S, CL (shrink, swell)
Rooting conditions	Effective soil depth	cm	>150	75-150	75-50	<50
Soil toxicity	pH		6.5-7.0	7.0-7.5, 5.0-6.5	7.5-8.0, 4.0-5.0	>8.0, <4.0
Erosion hazard	Slope	%	3-10	10-15	15-20	>20
Rainfall	Range	mm	1250-3000	1250	-	-
Light (PAR)	Range	%	50	30-50	-	-
CL-Clay Loam, L-Loam, SCL-Sandy Clay Loam, C-Clay, LS-Loamy Sand, S-Sandy, SL-Sandy Loam Requires irrigation during rainless period						



## COCOA TYPES

Characters	Criollo	Forastero	Trinitario
			
<b>Pod colour</b>	Red to Orange (ripe)	Green to Yellow (ripe)	Intermediates/ Mixtures
<b>Pod shape</b>	Pronounced point, thin wall, rough surface	Melon shaped, rounded, smooth, inconspicuous	Husk texture- hard
<b>Bean colour</b>	White/ ivory cotyledons, plumpy	Pale to deep purple cotyledons, flat	Variable in colour, rarely white
<b>Bean number</b>	20-30/ pod	30 or more	30 or more
<b>Fermentation</b>	Very quick (3 days)	Slow (6 days)	Intermediate
<b>Flavour</b>	Bland & Pleasant	Harsh & Bitter	Mixture
<b>Vigour</b>	Less vigorous	More vigorous	Intermediate
<b>Adaptability</b>	Less	Wider	Wider
<b>Reaction to pests and diseases</b>	Susceptible	Tolerant	Tolerant
<b>Types</b>	Central and South American Criollos (Native/Fine cocoa)	Amelonado, Comum, Nacional, Matina or Ceylan and Guiana (Basic cocoa).	Trinidad, Asian hybrids (Natural cross between Criollos x Forasteros, Bulk/Cultivated cocoa)



## COCOA HYBRIDS

**VTLCH 1**  
**Vittal Cocoa**  
**Hybrid 1**



- Vigorous, heavy bearer
- 50 yellow pods/tree/year
- No. of beans/pod- 42
- Single dry bean weight- 1 to 1.1 g
- Dry bean yield/tree/year- 1.48 kg
- Yield/ha- 1014 kg
- Shelling- 13%
- Nib recovery- 87%
- Fat content- 53.6%

**VTLCH 3**  
**Vittal Cocoa**  
**Hybrid 3**



- Heavy bearer, suitable for water limited conditions
- 45 yellow pods/tree/year
- No. of beans/pod- 45
- Single dry bean weight- 1 to 1.05 g
- Dry bean yield/tree/year- 1.45 kg
- Yield/ha- 993 kg
- Shelling- 13%
- Nib recovery- 87%
- Fat content- 50%

**VTLCH 2**  
**Vittal Cocoa**  
**Hybrid 2**



- Early, high yielder, tolerant to black pod rot
- 70 yellow pods/tree/year
- No. of beans/pod- 40
- Single dry bean weight- 1 to 1.5 g
- Dry bean yield/tree/year- 1.15 kg
- Yield/ha- 800 kg
- Shelling- 11%
- Nib recovery- 89%
- Fat content- 54%

**VTLCH 4**  
**Vittal Cocoa**  
**Hybrid 4**



- Heavy bearer, suitable for water limited conditions
- 40 red pods/tree/year
- No. of beans/pod- 43
- Single dry bean weight- 1 to 1.07 g
- Dry bean yield/tree/year- 1.25 kg
- Yield/ha- 856 kg
- Shelling- 12%
- Nib recovery- 88%
- Fat content- 50%



## COCOA VARIETIES

### VTLCC 1 Vittal Cocoa Clone 1



- Early, high and stable yielder
- Self and cross compatible clone
- Suitable for traditional, non-traditional and north-eastern zones
- 75 yellow pods/tree/year
- No. of beans/pod- 37
- Single dry bean weight- 0.9 to 1.05 g
- Dry bean yield/tree/year- 1.33 kg
- Yield/ha- 911 kg
- Shelling- 12%
- Nib recovery- 88%
- Fat content- 52.5%

### VTLCC 2 Vittal Cocoa Clone 2



- Stable high yielder, suitable for both arecanut and coconut gardens
- Bold and bigger beans, withstands both biotic and abiotic stress
- Suitable for all southern states
- 55 yellow pods/tree/year
- No. of beans/pod- 42
- Single dry bean weight- 1.21 g
- Dry bean yield/tree/year- 2.7 kg
- Yield/ha- 1850 kg
- Shelling- 15%
- Nib recovery- 85%
- Fat content- 53%

### VTLCS 1 Vittal Cocoa Selection 1



- Stable high yielder, suitable for both arecanut and coconut gardens
- Tolerant to low moisture stress, pod rot and tea mosquito bug
- Suitable for traditional, non-traditional and north-eastern zones
- 55 red pods/tree/year
- No. of beans/pod- 42
- Single dry bean weight- 1.13 g
- Dry bean yield/tree/year- 2.52 kg
- Yield/ha- 1700 kg
- Shelling- 11%
- Nib recovery- 89%
- Fat content- 52.1%

### VTLCH 5 Vittal Cocoa Hybrid 5



- Early, high yielder with medium canopy, moderately tolerant to black pod rot, tea mosquito bug and low moisture stress.
- Suitable for high density planting.
- 66 yellow pods/tree/year
- No. of beans/pod- 43
- Single dry bean weight- 1 to 1.11 g
- Dry bean yield/tree/year- 2.5 to 3 kg
- Yield/ha- 1500- 1800 kg
- Shelling- 11%
- Nib recovery- 88%
- Fat content- 52%

It is advised to plant and grow multiple varieties or mixture of clones to overcome the problem of incompatibility and to increase the productivity per unit area

## SEED GARDENS COCOA NURSERY

- Seed pods to be collected from mother trees of Forasteros and Trinitarios which bear 50-100 pods/tree/year after twelve years of age.
- Pods should be of 350 g weight with smooth or shallow furrows on the surface without prominent constriction at the neck and husk thickness of 1 cm with an average of >35 bold beans from the middle portion of the pod.
- Poly bag nursery with black polybags of 6"x 9" size, 250 gauge thickness with 9 drain holes, potting mixture- 2:1:1 Soil : Sand : FYM.
- Once pods are opened, seeds should be sown immediately after removing the mucilage. Shallow horizontal sowing is preferred.
- It is desirable to collect seeds from biclinal or polyclonal seed gardens to ensure quality of planting material.
- Vermicompost, coir compost, areca husk, cocoa husk/shell composts can also be used as potting mixture components.
- Four to five months old seedlings are preferred for planting.
- Occurrence of self-incompatibility in cocoa leads to lot of variability in the population and so vegetative propagation is practised through patch budding and soft wood grafting for multiplication of identified elite clones/varieties.

**Seedling**



**Graft**



**Budded plant**





## SEED GARDENS OR CLONAL ORCHARDS

Presence of self-incompatibility is observed in many cocoa populations. Self-incompatible but cross-compatible genotypes are being utilised in hybrid seed production. The purpose of seed garden or clonal orchard is to produce seeds of known parentage and proven performance. Based on earlier progeny trials, best combining parents are selected, multiplied as clones and established as seed gardens or clonal orchards. These well designed gardens will produce hybrid pods through natural cross pollination. If, the orchards are assembled with two self-incompatible and cross-compatible parents they are called as bi-clonal orchards and if planted with multiple self-incompatible and cross-compatible clones they are designated as poly-clonal orchards. It is important to establish such clonal gardens in research institutes and regional nurseries to meet out the future demand of seedlings.

**Bi-clonal orchard**



**Poly-clonal orchard**





## PLANTING SYSTEM

### Under Arecanut



- ✓ Arecanut spacing 2.7 m x 2.7 m
- ✓ Cocoa in the centre of four areca palms at 2.7 m x 5.4 m (9 ft x 18 ft)
- ✓ 686 plants/ha
- ✓ High density multispecies cropping system
- Arecanut- 2.7 m x 2.7 m
- Cocoa- 2.7 m x 5.4 m
- Banana- 2.7 m x 5.4 m
- Pepper (trailed on arecanut)- 2.7 m x 5.4 m
- ✓ Spacing of 3 m and above both for arecanut and cocoa can be followed if they are planted together in new plantation.

### Under Coconut



- ✓ Coconut spacing 7.5 m x 7.5 m
- ✓ Cocoa in the centre of two rows of coconut at 2.7 to 3 m spacing in single hedge system.
- ✓ 3 m x 7.5 m (10 ft x 25 ft)= 444 trees/ha
- ✓ When the spacing of coconut is more, double hedge of cocoa with 2.5 to 2.7 m may be followed. 800 trees/ha
- ✓ 3 m away from palm is advised to avoid damage due to fallen fronds and 3 m between cocoa is also advised.

### Under Oil Palm



- ✓ Oil palm spacing 9.9 or 10.5 m triangular plantings.
- ✓ Cocoa at 2.4 to 3 m spacing. 400 plants/ha
- ✓ Cocoa should be 2 m away from the base of palm.
- ✓ Shade in oil palm plantations is very high and so age of the palms/wider spaced gardens/square plantings are to be considered.



## FERTILIZER APPLICATION

Annual application of 100 g N, 40 g P<sub>2</sub>O<sub>5</sub> and 140 g K<sub>2</sub>O per tree in two equal splits, first dose in April-May and the second dose in September-October i.e. pre and post monsoon applications is recommended. Fertilizer may be applied uniformly around the base of the tree up to a radius of 30 cm (1 ft) 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 (2.5 ft). This radius may be increased gradually upto 90 cm (3 ft) after third year. Additional application of potassium in split doses is suggested in plants giving >1 kg dry beans.

Fertilizer (g/plant/year)	I year	II year	III year onwards	Fertigation
Nitrogen	33	66	100	Urea- 107 g Diammonium Phosphate- 145 g Muriate of Potash- 180 g
Phosphorous	13	26	40	
Potash	46	92	140	
Urea	72	144	220	
Rock phosphate	65	130	200	
Muriate of Potash	77	154	230	
Shallow basins	1 ft	2.5 ft	3 ft	

## IRRIGATION

Cocoa plants require continuous supply of moisture for optimum growth and yield. Adequate irrigation is very important in both mono cropping and mixed cropping systems. Summer irrigation at weekly interval is essential in cocoa cultivation which coincides with flowering, fruit set and cherelle/pod development. With flood/furrow irrigation trees should be irrigated once in five days with 175 litres of water and through drip with 20 liters of water/day/tree.



## COCOA PRUNING

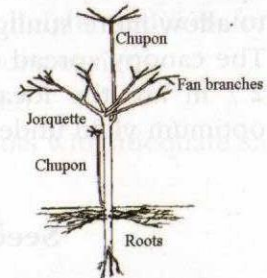
Pruning is an important operation in cocoa cultivation, since it is being grown as a mixed crop under palms which necessitated reduction of size of tree and canopy architecturing to induce flowering and efficient fruiting. The growth pattern of cocoa is specific and with typical branching in tiers. Initially the plant grows vertically to a height of 1 m and stops to produce 5 fan branches. This point where the vertical growth stops and lateral branches formed is called jorquette. The branches are called fan shoots. Jorqueting generally occurs from 6 to 12 months after planting. After some time these jorquettes will give rise to orthotropic shoots (chupons) from below which further produces fans, which will continue until the plant reaches to 4 to 10 m.

### FORMATION PRUNING/ TRAINING IN YOUNG PLANTS

#### Objectives:

1. To design the height of first jorquette
  2. To decide the no. of jorquettes/tree
  3. To allow optimal no. of fans/ jorquette
- ✓ 6 to 12 months old clones/seedlings are to be trained and architected with formation pruning.
  - ✓ Jorqueting height to be restricted to 1-1.5 m in the intercropping system.
  - ✓ Maintain the canopy to single tier by regular removal and limiting the number of chupons arising from the main stem below the jorquette.

- ✓ If plants jorquette at lower levels, it will affect the various cultural operations.
- ✓ Nip the fan branches close to the jorquette immediately after development. This will facilitate development of chupons just below the cut portion.
- ✓ Among the many chupons allow the most vigorous and straight one to grow and remove others.
- ✓ This chupon will further leads to fans at desired height.
- ✓ If there is two stems in a plant, retain the most vigourous one and remove the other.





## PRUNING IN MATURE TREES

**Structural pruning:** It is being done to shape the canopy to desired size and architecture.

### Pruning of seedlings

- ✓ Adjust the height of first jorquette between 1 to 2 meters and retain 4 strong fan branches in four directions to balance.
- ✓ Vertical height restricted to first jorquette.
- ✓ Canopy spread is to be architected to umbrella/ cone shape.
- ✓ Later, champagne cup/ 'Y' shaped tree with open centre system of pruning may be followed to allow more sunlight in grown up trees.
- ✓ The canopy spread of 3.8 to 4.0 m and height 2.7 m are the ideal canopy architecture for optimum yield under arecanut and coconut.

### Pruning of grafted plants

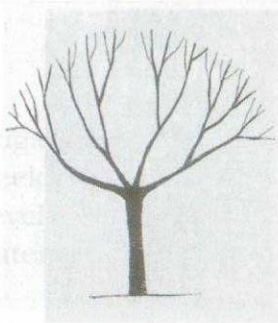
#### Primary pruning:

- ✓ In the first year of planting, supporting framework of one or more upward growing main stems are allowed in clonal plants.
- ✓ Then drooping or inward growing branches are removed.

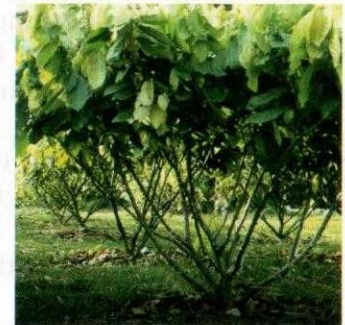
#### Secondary pruning:

- ✓ From third year onwards, canopy is architected as umbrella or cone shaped.
- ✓ Canopy of 3.8 m to 4.2 m spread and 2.7 m height is recommended in arecanut and coconut gardens.
- ✓ Funnel shaped canopy is also recommended in the later stages.

**Seedling tree**



**Clonal tree**





### Sanitary pruning:

- Diseased or unwanted branches with vascular die back are removed regularly to maintain the health and vigour of the tree.
- Removal of additional branches within 60 cm of the jorquette.
- Removal of excess chupons, water shoots, dead branches, epiphytes, climbing plants, ant nests, rodent-damaged, rotten and over ripe pods at regular intervals.
- Maintain maximum leaf area and avoid self-shading of leaves with trimming. Prune the trees to retain 20-30 leaves/developing pod.
- Pruning is usually done annually in August-September after main harvest. Light pruning is practised during June-July in Kerala and Karnataka and during November-December in Andhra Pradesh and Tamil Nadu.
- Proper pruning of cocoa ensures adequate ventilation in garden, maintain tree height, reduces fungal infection, contain the spread of diseases and makes spraying and harvesting operations easier.
- Coconut provides lots of space and so two-storey canopy architecture may be allowed.
- Maintenance pruning may be taken up 2-3 times a year in humid environment and plots with adequate shade and water.
- It is optimum to have a canopy area of 15-20 m<sup>2</sup> under palm based cropping system.
- 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, apply fungicides (Bordeaux paste) immediately after the pruning.
- Pruned big branches to be removed from the plots and small branches and leaves may be applied as mulch in the cocoa basin. Around 1000 kg/ha/year as organic matter is returned to the soil through prunes/cocoa litter.

## COCOA DISEASES

### Seedling dieback/ seedling blight

(*Phytophthora palmivora*)

Seedling dieback/blight is very common in cocoa nurseries.

Intensity of these diseases varies with the age of seedlings and rainfall.

#### Symptoms:

**Dieback:** Drying and dying of sprouts from the tip to downwards.

**Blight:** Infection mainly starts from the grafted or budded region and proceeds both upwards and downwards.

Continuous spreading of infection internally affecting vascular tissues causing yellowing and blighted symptoms after the rainy season, leading to high mortality.



#### Management:

- Removal and destruction of infected seedlings.
- Improving drainage facilities and providing proper shade in the nursery.
- Solarisation of potting mixture under hot sun or covering with black polythene sheets during summer and sowing seeds well before the onset of monsoon will prevent the disease occurrence.
- Bio-priming with 25 g Cocoa Probio (*Pseudomonas putida*) or *Trichoderma harzianum* (isolate CPTD-28) microbial culture enhances health and vigour of seedlings.
- Drenching the seedlings with Bordeaux mixture (1%) or copper-oxy-chloride (0.2%) just before the onset of monsoon and thereafter at frequent (15 days) intervals.





## Cherelle wilt

The young developing pod/fruit is known as cherelle. Large number of young pods of 2-3 months old will dry up and remain on the tree as mummified fruit. This type of drying up of immature fruits is called as “cherelle wilt”.

Two causes has been identified, one is considered as a physiological thinning mechanism and another is pathological wilting.

February-May months are considered as critical period for infection; where plenty of susceptible immature pods or cherelles are available. High temperature (28-30° C) and low humidity (<70% RH) favors the disease.

### Symptoms:

#### Physiological wilt

- Begins as general yellowing of the whole pod followed by browning and blackening of the entire pod.

#### Pathological wilting (*Colletotrichum gloeosporioides*)

- Infection appears as a small water soaked lesion on stalk then it spreads towards the tip of the pod (Infection can also appears anywhere on pod surface other than stalk).
- Close observations reveals presence of sunken spots with diffused yellow halo.
- Presence of pinkish slimy mass on the lesion and mummification of pods.

### Management:

- Fungicidal spraying with carbendazim @ 0.05% or mancozeb @ 0.2%



### **Black pod disease or Pod rot (*Phytophthora* spp.)**

Black pod disease occurs during south west monsoon season (June-September) when humidity is more and temperature is constantly optimum.

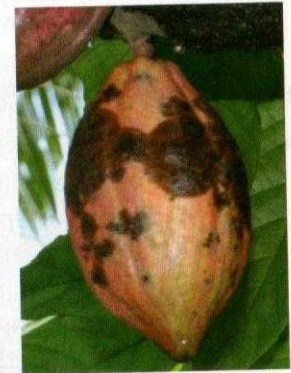
Rain splash helps in dispersal of spores, which infects other parts of the tree.

#### **Symptoms:**

- Pathogen can infect pods of all stages of development. Infection appears as small circular water soaked lesion and later it turns to dark brown colour spot.
- Within 14 days of initial infection, entire pod turn to black colour.
- A white thread like mycelial growth consisting of numerous sporangia of the pathogen are seen on the pod surface.
- Infected pods when cut open, show discoloration in beans which affects the quality of the produce.

#### **Management:**

- Practices like Phytosanitation, removal and destruction of infected pods and fallen leaves should be followed.
- Pruning of branches in order to facilitate the sun light entry.
- In severely affected garden, spraying of Bordeaux mixture (1%) at 45 days interval starting from the onset of south- west monsoon along with periodic removal of infected pods.







## **Charcoal pod rot (*Lasiodiplodia theobromae*)**

### **Symptoms:**

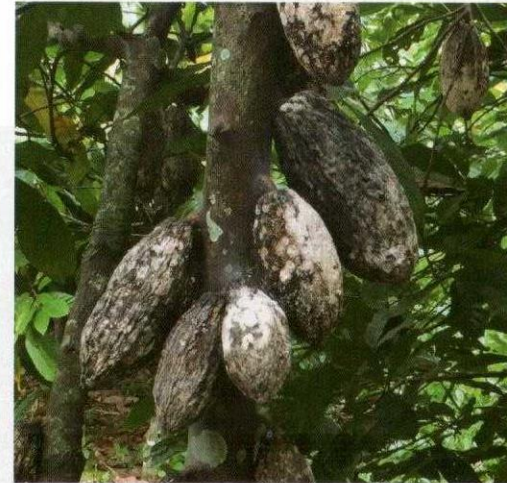
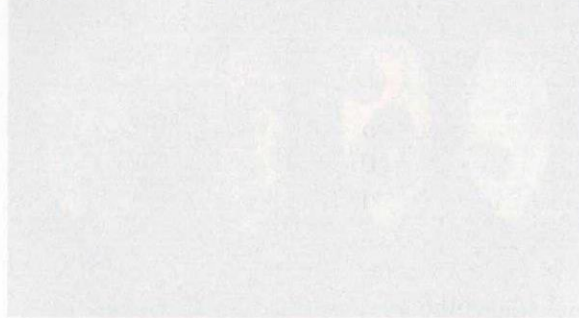
- Occurs throughout the year, becomes severe during summer months.
- Pods of all ages are susceptible.
- Infection appears as dark brown to black coloured spot. The affected spots turn black and remain on the tree as mummified fruit.
- The internal tissues are rotten and the affected beans turn black.



- Spores appear in masses forming a soot.
- Infection takes place through wounds.

### **Management:**

- Spray Bordeaux mixture (1%) to control this disease.





## Stem canker (*Phytophthora palmivora*)

It affects stem, flower cushions, jorquette and fan branches. In early stage of disease development it is difficult to detect the symptoms and so close observation is required.

Stem canker disease symptoms appears after monsoon. Shade and more humidity favors the disease.

### Symptoms:

- Dark brown, round to oval shaped discolored area are formed on the bark.
- Oozing of reddish brown liquid from the infected area.
- Girdling of infected stem
- At the collar region canker lesion will be bigger and it spreads fast and infects the below ground root system and affects water and nutrient uptake from plants.
- Yellowing and wilting symptoms followed by death of plant.

### Management:

- Phytosanitation practices like removal and destruction of black pod infected pods and fallen leaves.
- If mulching is practiced, avoid trunk covering or mulch 1 feet away from the trunk.
- Providing good drainage facility in the garden.
- Proper pruning twice in a year.
- The disease can be controlled in the early stage by removing the infected tissues and applying Bordeaux paste (10%).
- Wound treatment and soil application with *Trichoderma* coir pith cake, helps in long term management of the disease.





### White thread blight (*Marasmius scandens*)

White thread blight is observed in some of the gardens in Kerala and Karnataka states.

#### Symptoms:

- 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 (>90%) 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.

#### Management:

- Removal and burning of the affected parts.
- Removal of heavy shade will also help in the control of the disease.
- Spray Bordeaux mixture (1%) to control this disease.



### Cushion Galls

Cushion gall is observed in few gardens of India with two types of galls namely, knob galls and fan galls. Green point gall, flowery gall and disc gall types are reported in other countries.

- Knob gall affected trees are found to bear 4-6 galls on the main trunk below the jorquette.
- The galls occur on the cushions as hard, woody swellings with a smooth surface and do not bear flowers.
- Neither fungi nor bacteria could be isolated from the galls and so cause of this abnormality is unknown.
- If, few gall bearing trees are found, the trees should be removed and destroyed at once and recommended regular inspection in susceptible areas.





## Vascular streak dieback (VSD) (*Ceratobasidium theobromae*)

Infections occur only during wet weather conditions; for infection to occur a film of water on the surface of leaf is very much essential.

### Symptoms:

- Typical symptom of vascular streak dieback includes yellowing of one or two leaves of second or third flush behind shoot tip.
- Affected leaf dries and it falls off from the tree, youngest and oldest leaves will remain intact.
- When we cut open the stem, we can see long longitudinal brown streak. This is due to infection of xylem vessels by this pathogen.



### Management:

- Identification and uprooting of severely infected plant followed by destruction of the inoculum by burning fallen leaves and infected plants.
- Pruning of infected branches; 30-40 cm below the end of visible brown streaking.
- Swab the cut ends of the plants with Bordeaux paste (10%)
- As a prophylactic measure, spray the plant with Bordeaux mixture @ 1% or copper oxy chloride @ 0.25% twice in a year during May-June and October months.
- Soil drenching with 0.25% copper oxy chloride (2.5 g/ litre of water)



## Zinc deficiency

Observed in neutral/alkaline/sandy soils having low organic matter and high available phosphorus

### Symptoms:

- Chlorosis of the leaves
- Vein- banding
- Mottling and crinkling with wavy margin
- Younger leaves become narrow and sickle shaped
- Twigs shows shortened internodes or rosette appearance

### Management:

- Zinc deficiency can be corrected by foliar spray of a mixture of 0.3% zinc sulphate (3 g in 10 litre of water) and 0.15% (w/v) lime.



## Iron deficiency

Observed in black/sandy soils with high lime and manganese contents

### Symptoms:

- Younger leaves showing darker green veins against paler green background, or showing green tinted veins against pale yellowish white or almost completely white background, developing tip scorch.
- Older leaves frequently show narrow marginal and tip scorch.

### Management:

- Iron deficiency is occasionally seen and can be cured by repeated spraying of 1 per cent aqueous Ferrous sulphate solution.





## PREPARATION OF BORDEAUX MIXTURE

### Preparation of 1% Bordeaux mixture

- Dissolve 1 kg copper sulphate crystals in 10 litres of water in a plastic container.
- Dissolve required quantity\* of quick lime in 10 litres of cold or hot water in another plastic container.  
\*Note : If quick lime is used, 750-850 g is needed and if hydrated lime is used, 375-450 g is needed to neutralize the copper sulphate solution.
- Pour both the copper sulphate and quick lime solutions simultaneously to 80 litres of water with constant stirring and check for the pH until it becomes neutral pH of 7.0.
- The mixture should be tested for its neutrality of the pH because; the free radicals of the copper are toxic to the plants. The pH should be checked before adding the wetting agent.
- To test the neutrality of the pH, either pH paper or a well-polished knife or a sickle can be used for checking.
- Dip pH paper in the solution and if it turns blue it indicates that the mixture is neutral.
- Dip a well-polished knife or sickle into the mixture. If the blade shows a reddish colour, add lime to the mixture till the blade does not show staining on dipping the knife in the prepared solution.
- Prepare wetting agent at 1ml/litre of the spray solution and it should be added to the above prepared solution before spraying. Mist nozzle should be used for effective spraying.

### Preparation of 10% Bordeaux paste

- For preparation of 10% Bordeaux paste, 100 g copper sulphate and 100 g quick lime each are dissolved in 500 ml of water separately and mixed thoroughly until to get a paste.
- Uses: 1% Bordeaux mixture is recommended twice as prophylactic spray. First spray during pre-monsoon showers and the second spray after 40-45 days of first spray in the coconut, arecanut and cocoa orchards for the *Phytophthora* disease management. Bordeaux paste can be used for swabbing the pruned regions of cocoa plant and also in the coconut/arecanut crown portion after removing the diseased spindle leaves.

### Precautions:

1. The solution should be prepared fresh always in the earthen or wooden or plastic containers.
2. The prepared Bordeaux mixture should be sprayed within 4-5 hrs.
3. At the time of preparation and spraying proper stirring is required. Don't add hot water.



## COCOA PESTS

### Tea mosquito bug (TMB) (*Helopeltis* spp.)

#### Symptoms:

*Helopeltis bradyi* and *Helopeltis theivora* are commonly observed infesting cocoa.

- Tea mosquito bugs are quite damaging in cocoa gardens adjoining cashew plantations. Nymphs and adults feed primarily on the pods in all stages of development as well as on young shoots.
- Typical feeding damage appears as a discoloured, necrotic area or lesion around the point of entry of the labial stylets into the plant tissue that becomes darker with age as the tissue around the puncture dries.
- Damage on pods appears as dark, circular lesions externally visible as hardened scars on the pods.

#### Management:

- Shade regulation through proper pruning and training will reduce TMB damage.
- Removal of alternate hosts like neem, cashew, guava in the surroundings.
- If infestation is less, neem oil 3% may be sprayed.
- If infestation persists, spray may be repeated at 20 to 30 days interval, one spray each during flushing, flowering and fruiting seasons. Spraying shall be resorted during morning hours.
- If infestation is severe, spray any one of following insecticides viz., Lamdacyhalothrin 5EC (0.003 %) 0.3 ml /L (or) Imidacloprid 17.8 SL (0.004%) 0.25 ml /L.





## Mealy bug (*Planococcus lilacinus* and *P. citri*)

### Symptoms:

- Mealy bug is emerging pest of cocoa in India, confined during summer.
- Nymphs and adult females occur in colonies and infest growing shoots, foliage, terminal buds, flower stalks, pods by sucking the sap.
- Flower development is affected, young pods dry up and tender leaves are deformed into hair like structures.
- Reduction in the vigor of pod is common in severely affected gardens.
- 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.
- Sunken patches are seen in developing pods because of sucking leads to formation of scabs.
- Brown patches, irregular cracks and furrows seen on mature pods.
- The adults excrete honey dew on the leaves leads to sooty mould development which affects photosynthesis.
- The red ant, *Oecophylla smaragdina* is usually associated with the pest encouraging phoretic behavior and shielding the pest from predators.

### Management:

- Conservation of lady beetles belonging to *Pullus* spp. as well as Lycaenid, *Spalgius epius* encourage bio-suppression of mealy bugs.
- On incidence of *Paracoccus marginatus* field release of the parasitoid *Acerophagus papayae* @ 100/ hamlet is recommended
- Spot application on the pest loci with 0.5% neem oil emulsion two-times at fortnightly intervals or need-based application of Imidacloprid @ 0.3 ml/L of water or Dimethoate 30 EC @ 1.6 ml/L of water.





## **Aphids (*Toxoptera aurantii*)**

### **Symptoms:**

- Aphids colonize terminal and growing shoots of cocoa causing leaf deformation during summer.
- They can also colonize on succulent stem, flower buds and small cherelles which may cause premature shedding of flowers and curling of leaves. Extensive damage is not reported.

### **Management:**

- A number of natural enemies feed on aphids and exert natural check.
- Spot application of Dimethoate at 1.6 ml/L of water is suggested if infestation is severe.



## **Leaf eating caterpillar (*Lymantria ampla*)**

### **Symptoms:**

- The caterpillars cause severe damage on leaves in young plants.
- The early-instar larvae feed on leaves or the surface tissues of growing pods during day and night, but later instar caterpillars are nocturnal in habit. Their population increases after the monsoon rains.

### **Management:**

- If the damage is very severe, neem oil (0.5%) spraying could be given.





## Stem borer/ Stem girdler

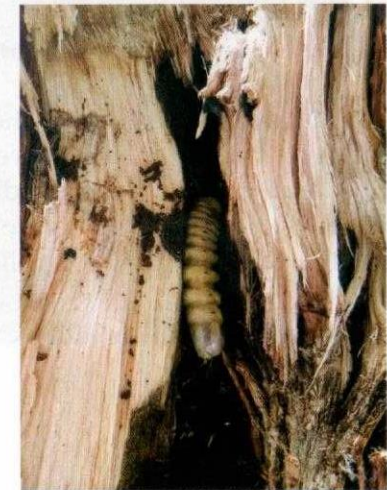
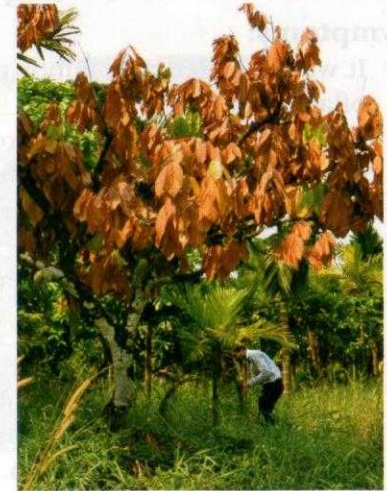
(*Zeuzera coffeae*/ *Sthenias grisator*)

### Symptoms:

- Grubs tunnel the bark initially 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.
- In big trees it affect the main stem or trunk region.
- Infestation is quite severe where cocoa is planted in forest cleared tracts or planted near forest zones.

### Management:

- Mechanical collection with iron spike or needle stick and destruction of grubs from the affected branches.
- Clean the webs, excreta and plug the holes with cotton wool soaked with Chloroform, Formalin or Petrol and seal it with mud.
- Place Chlorpyrifos 0.05% soaked cotton and fasten with polythene tape.
- Swab Coal tar + Kerosene @ 1:2 (basal portion of the trunk – 3 feet height) after scraping the loose bark to prevent oviposition by adults.
- Farm should be clean, overcrowding of trees and branches to be avoided. Cut and burn the dead and severely affected branches.
- Too much dumping of pruned branches and weeded grass in the tree basin to be avoided.



## Cocoa fruit borer (*Conogethes punctiferalis*)

### Symptoms:

- It was reported as a minor pest but gaining key pest status of late.
- Caterpillar after hatching from eggs feed on rind/ husk of cocoa pods later bore and feed the internal contents of the pods extruding the granular faecal pellets through the bore holes.
- Found in most cushion bearing trees where the pods are too compact.

### Management:

- Collection and destruction of infested pods
- Planting preferred hosts such as Castor along the field borders as a trap crop.



## Red banded thrips (*Selenothrips rubrocinctus*)

Adults and nymphs of the thrips appear in colonies on the under surface of the leaves and also on the pods. The thrips feed on the fluid exuding from the scraped tissues. Infested leaves turn pale green to pale brown and dry up later. The thrips can be controlled by the application of 0.05% Quinalphos.





## **Rodents- Rats (*Rattus rattus*) and Squirrels (*Funambulus tristriatus* and *F. palmarum*)**

These vertebrate pests feed on the mucilage covering of the beans and cause serious damage to the pods.

### **Rat damage**

#### **Symptoms:**

- The rats usually gnaw the pods near the stalk portion
- The rats are known to damage the mature as well as immature cocoa pods

#### **Management:**

- The rats can be kept under check by keeping 10 g Bromadiolone (0.005%) wax cakes on the branches of cocoa trees twice at an interval of 10-12 days and rat traps can also be used with fried coconut pieces.



### **Squirrel damage**

#### **Symptoms:**

- Squirrels gnaw the pods in the centre
- Squirrels damage only the mature ones.

#### **Management:**

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



## **Precautions of insecticide spray in cocoa gardens**

Most of the insects have their own natural enemies and so chemical sprays are recommended in severe conditions only.

- Indiscriminate use of synthetic pyrethroids may be avoided as it causes flare-up of sucking pests.
- Insecticides should be sprayed in evening hours to avoid toxicity to the insect pollinators.
- Insecticides should be altered in such a way that their modes of actions are different.
- Insecticides should be applied only to manage the rising pest population as per requirement, not as a routine spray.
- Recommended dose of chemicals should be followed and avoid sub- and supra-lethal doses. Sub-lethal doses would not only be ineffective but also may help in the development of resistant strains, while overdose of pesticide would invariably increase the cost, pollute the environment and lead to the undesirable residue problems.
- Detection and marking of the initial pest-build up sites can help contending and managing the pest through spot spraying. Such operation would reduce the pesticide load that results from routine and blanket applications.
- Nymphs and adults of certain insects generally feed in the morning and late afternoon hours. Hence, spraying operation against this pest should be carried out early in the morning or late in the afternoon. Spraying during the hot midday hours should be avoided as strong sunshine may cause decay of the insecticide.
- Toxicity persistence of different insecticides at recommended dose falls between 7 to 16 days. Hence, interval between two subsequent sprays must be 7 to 15 days.
- Nozzle type should give mist spray type.
- An on average one litre of spray fluid required for one well grown up cocoa tree of 8 to 12 years old. Whereas, 2 liters of spray fluid required for 15 to 20 years old cocoa trees, but it may vary based on the foliage density and size of tree.



## HARVESTING AND PROCESSING

Cocoa starts flowering from second year after planting in clones and fourth year in seedlings. Even though, cocoa produces flowers throughout the year especially under irrigated condition, main flowering occurs during December-March. Pods are ready for harvest after 135-170 days of successful pollination. Generally, cocoa gives two main crops in a year i.e., May-July and October-December in Kerala and Karnataka conditions, whereas in Pollachi region of Tamil Nadu major fruiting is in October. Changing climate and both macro and micro environments have a definite impact of flowering and fruiting in cocoa especially temperature and rainfall patterns. Year round flowering and fruiting is observed in adapted genotypes with optimal shade, sufficient irrigation and with multiple pruning regimes.

Kerala/ Karnataka	May-July- main harvest October-December - second crop
Tamil Nadu	June-July - main harvest November-January - second harvest
Andhra Pradesh	January-June - main harvest July-December - second harvest

The stage of maturity is best judged by change of colour of pods i.e., from green (unripe) to yellow (ripe) or red (unripe) to orange (ripe). Under-ripe pods will affect the quality of beans and over-ripe pods end up in viviparous germination. Maturity stage of pods and timely harvest is crucial for cocoa processing. Pods may remain on the tree without damage up to a month and they can be harvested at an interval of 10-15 days. The pods are harvested by cutting the stalk with the help of a sharp knife. CPCRI developed a cocoa harvester with light weighted telescopic pipe and sharp blades. The harvested pods can be kept for a minimum period of two days before opening, however the pods should not be kept beyond four days. It enhances the pre fermentation activity inside pods. Diseased, damaged, unripe, over-ripe and rotten pods have to be separated out to ensure quality of end product. For breaking the pods wooden hammer or mallet may be used. After breaking the pods crosswise, the placenta should be removed together with husk and the beans are collected for processing. Fresh husk can be used as cattle feed and also composted for used as a component in potting mixture. Each pod will have 25-45 beans embedded in white pulp or mucilage which is important for fermentation.



## **Fermentation:**

Fermentation of cocoa beans is essential to remove the adhering mucilaginous pulp, kill the germ of the seed, loosen the testa, develop color, flavour and aroma precursors and to reduce bitterness.

The different methods of fermentation are (1) heap (2) basket (3) box and (4) tray methods. Based on the quantity of beans method of processing may be selected. During fermentation process, beans are covered with banana leaves/gunny bags to generate heat. Fermentation normally takes 6-7 days. Beans are mixed/turned on 3<sup>rd</sup> and 5<sup>th</sup> day to ensure uniform distribution of heat. The fermentation is said to be complete when the beans attain a reddish brown colour, which usually occurs by the sixth day. Incomplete fermentation makes the cured beans bitter and astringent.

### **1. Heap method:**

Wet beans (minimum of 50 kg) are placed over a layer of banana leaves kept over few sticks to keep them little raised on sloppy floor or raised platform, and covered with banana leaves on the first day and with gunny bags on the second day. On the 3<sup>rd</sup> and 5<sup>th</sup> day, the heap is dismantled and beans are mixed and kept again in position. Fermentation will be completed on the sixth day and are taken out for drying on seventh day.

### **2. Basket method:**

Bamboo or cane baskets of suitable size could be used for fermenting small quantity (2-6 kg) of beans. One or two layers of banana leaves are placed at bottom with provision to drain the sweatings. The basket is filled with 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 sweatings for one day. Later the basket is covered with thick gunny bags. The beans are mixed thoroughly on the third and fifth days and covered with gunny bags. The fermentation will be completed at the end of the sixth day and the beans are withdrawn for drying.

### **3. Mini tray method:**

Wooden trays of 60 cm length, 25 cm width and 10 cm deep with slatted split cane bottoms divided into number of sections by means of wooden partition that will fit into appropriate grooves at required distances are employed in this method. About 10 kg wet beans are filled in these trays, then levelled and staked one above the other. The top tray is covered with gunny bag to keep the beans warm. Mixing is not necessary in this method, but fermentation gets completed in 4-5 days.



### **1. Tray method:**

Wooden trays of size 90 cm x 60 cm x 13 cm with reapers fixed at the bottom with gaps in between to allow flow of sweatings are used in this method. They are filled up to 10 cm with 45 kg beans and are stacked one up on the other in tiers of 6 to 12. After loading and stacking, trays are covered with gunny bags. An empty tray is kept at the bottom for draining of sweatings. On the 5<sup>th</sup> day, beans are taken out and dried. Single tray is also being used.

### **2. Box method:**

This method is more applicable to 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 sweatings from the pulp to drain out and to provide aeration, are used. The boxes could be arranged in tiers for transferring beans from one to the next in line below. Two detachable wooden planks are provided on one side of the box for transferring (mixing) the beans by removing, the planks. The beans are loaded in fermentation box and covered with banana leaves or gunny 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 about 42-48°C after about 48 hours of fermentation. Again transferring of beans is done at 72 hours of fermentation and the final transferring at 24 hr of fermentation. A total of six days (144 hours) are required to complete the fermentation.

### **3. Gunny bag method:**

Clean gunny bags and polythene lined bags are used in this method for small quantity of beans. Beans are filled loosely in the bags and allowed to drain sweatings for one day. The gunny bags are heaped one over the other and insulated properly to conserve the heat. The beans are mixed without opening the bag by shuddering on 3<sup>rd</sup> and 5<sup>th</sup> day. Beans are taken out for drying on the 7<sup>th</sup> day. In this method fungal infection is more in humid environments.

### **Drying:**

After the fermentation, the beans can be dried by sun-drying or artificial drying. The fermented cocoa beans have considerable moisture (55-69%) which has to be brought down to 6-7%.

#### **(i) Sun drying:**

Sun drying gives superior quality produce. The fermented beans are spread in a 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. When a fistful of beans are compressed in palm they produce a characteristic cracking sound with proper drying. Partially enclosed solar dryers can be used which could attain significantly high temperature and faster rate of drying (3-4 days), with better quality product. Sun drying is widely practised in Tamil Nadu and Andhra Pradesh states where the humidity and rainfall is less.

### **(ii) Artificial drying:**

During the monsoon period, artificial drying has to be adopted in Kerala and Karnataka states. Electric ovens or conventional Samoan type drier could be used. The duration of artificial drying varies from 48-96 (2-4 days) hrs. The drying of beans at high temperature should be avoided as it results in low quality end-product. Slow drying in the initial stage has given better quality beans. Mould growth has to be prevented during drying as it affects the appearance, colour and chocolate flavour of the beans.

### **(iii) Electric oven:**

The beans have 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 (3-4 days) hours. The beans are to be stirred at regular intervals for uniform drying and to prevent clump formation. The moisture content of the dry beans should be around 6-7 percent for safe storage.

### **Grading and storage:**

The dried beans after cooling to room temperature should be cleaned before storage. The flat, slaty, shrivelled, broken and other extraneous materials are to be 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**

Under normal cultivation conditions as a mixed crop in arecanut and coconut gardens, each cocoa tree is expected to yield 1 kg dry beans annually. When cocoa is grown under arecanut with a spacing of 2.7 m x 5.4 m, one hectare area accommodates about 650 trees with the yield potential of 650 to 1300 kg dry beans with an optimal canopy area of 15-20 m<sup>2</sup>. Potential yield upto 3-4 kg is obtained under coconut in cocoa trees with two storey canopy.





**Harvesting stage**



**CPCRI harvester**



**Pre fermentation**



**Pod breaking and collection of beans**



**Basket**



**Box**



**Tray**



**Gunny bag**



**Fermented beans**



**Sun drying**



**Oven drying**



## CALENDAR OF FARM OPERATIONS

### JANUARY

Nursery	Young garden	Old garden
<ul style="list-style-type: none"> <li>➤ Daily watering- mist/overhead sprinkler/hose</li> <li>➤ Weeding</li> <li>➤ Removal of lean and lanky seedlings and unsuccessful grafts</li> <li>➤ Nurseries which are in operation throughout the year with water facilities, if second season pods are available resowing can be done in ungerminated polybags. This seedlings will be ready for May- June planting</li> <li>➤ Rearranging polybags</li> <li>➤ Regrafting in unsuccessful rootstocks</li> <li>➤ Overhead shade maintenance with shade net/thatched leaves/plaited coconut fronds</li> </ul>	<ul style="list-style-type: none"> <li>➤ Removal of chupons arising from the rootstocks if grafts are planted and also from the seedlings</li> <li>➤ Irrigation- Once in five days with 175 litres of water with flood irrigation and 20 liters of water/day/plant with drip irrigation</li> <li>➤ Shading young seedlings with plaited coconut/palmyrah/areca leaves/shade nets</li> </ul>	<ul style="list-style-type: none"> <li>➤ 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/developing cherelles</li> <li>➤ If number of plants are less, hanging wilted cherelles may be removed gently</li> <li>➤ Rat and squirrel control- This rain free season is best for rodent control. Poison baiting and rat traps may be installed</li> </ul>

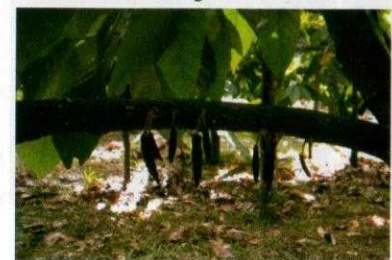
***Shade net nursery***



***Shading with Palmyrah leaves***



***Removal of cherelle***





## FEBRUARY

Nursery	Young garden	Old garden
<ul style="list-style-type: none"> <li>➤ Daily watering- mist/ over head sprinkler/ hose</li> <li>➤ Weekly weeding</li> <li>➤ Rearranging bags</li> <li>➤ Shade maintenance</li> </ul>	<ul style="list-style-type: none"> <li>➤ Flood irrigation may be given once in five days, drip-daily basis, check the drippers for clogs</li> <li>➤ If the existing plaited coconut fronds provided as shade to young seedlings/ grafts decomposed or damaged, replace with new one</li> <li>➤ In young plantations after weeding the cut weeds and palm leaves can be spread over the barren soil in between cocoa rows which enrich the organic content of the soil</li> <li>➤ Mulching with cocoa leaves in basin</li> <li>➤ Removal of chupons, diseased, dried, blackened pods and cherelles without damaging the flower cushions</li> </ul>	<ul style="list-style-type: none"> <li>➤ Daily irrigation is compulsory for developing flowers and cherelles</li> <li>➤ Removal of chupons, tea mosquito bug attacked shoots, dried chrelles and damaged pods without damaging the flower cushions</li> </ul>

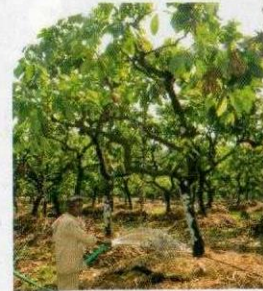
**Overhead sprinkler**



**Removal of chupons**



**Irrigation**





## CALENDAR OF OPERATIONS

### MARCH

Nursery	Young garden	Old garden
<ul style="list-style-type: none"> <li>➤ Daily watering- mist/ over head sprinkler/ hose</li> <li>➤ Regular supervision of shade net position</li> <li>➤ Tie the nets tightly over the pipes and pillars without bending</li> <li>➤ Cover the entire nursery area to allow filtered sunlight</li> <li>➤ Soil solarization may be taken up for 30-45 days for potting mixture preparation for the upcoming sowing season</li> </ul>	<ul style="list-style-type: none"> <li>➤ 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</li> <li>➤ Irrigation: flood- once in five days, drip- daily</li> <li>➤ Shade management with banana and other shade trees in the borders.</li> <li>➤ Remove excess number of banana suckers to reduce water usage</li> </ul>	<ul style="list-style-type: none"> <li>➤ Removal of chupons arising from the main stem</li> <li>➤ Take control measures for diseases like canker, charcoal pod rot and pests like mealy bugs and tea mosquito bugs</li> <li>➤ Observe for aphids, thrips and other minor pests on flushes, flowers, cherelles</li> </ul>

***Soil solarization***



***Compost/FYM application***



***Drip irrigation***





## APRIL

Nursery	Young garden	Old garden
<ul style="list-style-type: none"> <li>➤ Daily watering- mist/ over head sprinkler/ hose in the available seedlings</li> <li>➤ Soil solarization continued for preparation of potting mixture for current season nursery</li> <li>➤ Potting mixture preparation will be initiated either at the middle and end of April</li> <li>➤ Selection of mother trees for collection of seed pods</li> </ul>	<ul style="list-style-type: none"> <li>➤ Weeding: In young cocoa plantations weeding may be done through pcything, sickle cutting or machine weeding with weed cutter</li> <li>➤ Mulching cut weeds in the interspaces</li> <li>➤ Irrigation</li> </ul>	<ul style="list-style-type: none"> <li>➤ Forking, basin opening and application of farm yard manure/ compost</li> <li>➤ First dose of fertilizers may be applied at the end of April in the irrigated garden</li> <li>➤ Irrigate sufficiently after fertilizer application for efficient absorption</li> </ul>

***Potting mixture preparation***



***Machine weeding***



***Forking, basin opening***





## MAY

Nursery	Young garden	Old garden
<ul style="list-style-type: none"> <li>➤ Potting mixture preparation, poly bag filling and establishment of nursery</li> <li>➤ Collecting seed pods from clonal orchards or mother trees during this main harvest season</li> <li>➤ Seed pod selection, discarding malformed, under ripe, over ripe, diseased, damaged pods and selecting healthy pods</li> <li>➤ Sorting smooth seed pods, extraction of beans and sowing</li> <li>➤ Sowing should be completed by May 15<sup>th</sup> before onset of monsoon to effect proper germination</li> <li>➤ Watering through mist or overhead sprinkler</li> </ul>	<ul style="list-style-type: none"> <li>➤ Selection of site and laying out for new plantation in Kerala and Karnataka states</li> <li>➤ Pitting: Pits of 60 cm<sup>3</sup> (2 ft) should be taken 2-3 weeks before planting to ward off the field heat</li> <li>➤ Pit filling: Pit should be half filled with top soil and 5 kg Farm Yard Manure (FYM) or vermicompost one week before planting and while planting fill with bottom soil. Later annual application of 10 kg organic manure may be practised</li> <li>➤ Remove the polythene sheet tied over graft and keep the graft joint above the soil while planting</li> </ul>	<ul style="list-style-type: none"> <li>➤ Harvesting pods carefully with a knife or cocoa harvester without damaging the bark/ cushions.</li> <li>➤ Keep ripe pods for 3 days to enhance in situ fermentation</li> <li>➤ Manuring: If first dose of fertilizers were not given during April, this month it can be given with the onset of one shower of the monsoon</li> <li>➤ 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 <i>Phytophthora</i> infection in high rainfall areas</li> </ul>

**Sowing**



**Field planting**



**Harvesting**





## JUNE

Nursery	Young garden	Old garden
<ul style="list-style-type: none"> <li>➤ Weeding: Regular removal of weeds without disturbing the epigeal germination of seeds</li> <li>➤ Monitoring for incident of any diseases especially die back of seedlings</li> <li>➤ Provide sufficient drainage, channels should be cleared off of mud, stones, poly bags, dried leaves and grasses</li> </ul>	<ul style="list-style-type: none"> <li>➤ 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 in Andhra Pradesh</li> <li>➤ Plant the seedlings at the centre of the pit, heaping of soil around the seedling will give anchorage during rainy season</li> <li>➤ Mulching: After planting pit should be mulched with green leaves</li> <li>➤ Staking: Strong small sticks of <i>Glyricidia</i>/ Areca stem may be used as stakes for tying the young seedlings</li> <li>➤ Shading: Cover the seedlings with plaited coconut leaves and grow shade crops like banana in the interspaces</li> <li>➤ Sunhemp (green manure crop) seeds may also be sown in the interspaces as a soil reclamation measure</li> </ul>	<ul style="list-style-type: none"> <li>• 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</li> <li>➤ Clean the channels and improve the drainage facilities</li> <li>➤ Removal of chupons arising from the main stem</li> <li>➤ Regular harvest may be taken up once in 10 days</li> </ul>

**Cleaning of drainage**



**Mulching with green leaves**



**Drip rolling back**





## JULY

Nursery	Young garden	Old garden
<ul style="list-style-type: none"> <li>➤ Intermittent removal of weeds is necessary in young germinating seedlings</li> <li>➤ Mechanical killing of insects like grass hoppers and caterpillars may be done. Burning of diseased plants is advisable</li> <li>➤ Removal of shade nets during rainy season</li> <li>➤ Improve the drainage facilities</li> <li>➤ Take control measures for nursery diseases caused by <i>Photophthora</i> and <i>Colletotrichum</i>, if noticed.</li> </ul>	<ul style="list-style-type: none"> <li>➤ Planting season in western and southern Tamil Nadu</li> <li>➤ Removal of emerging shoots from the rootstock in field planted grafts</li> <li>➤ Gap filling: Replace the weak, dried and dead seedlings from the plot</li> <li>➤ Soil bunding at the base and anchoring the young seedlings to avoid falling and damaging during rainy season</li> <li>➤ 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.</li> </ul>	<ul style="list-style-type: none"> <li>➤ Ensure drainage facilities</li> <li>➤ Swab Bordeaux paste in cut ends of broken branches to avoid fungal infection</li> <li>➤ Need based plant protection should be given</li> <li>➤ Harvesting and fermentation of beans continued</li> <li>➤ Take control measures for pod rot, white thread blight, vascular streak dieback etc.</li> </ul>

**Spraying**



**Gap filling**



**Fermentation**





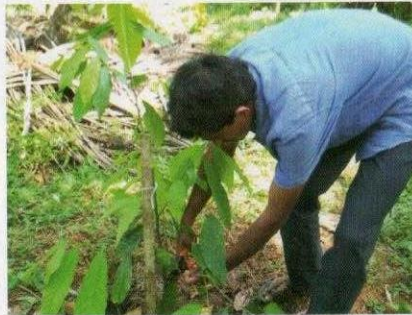
## AUGUST

Nursery	Young garden	Old garden
<ul style="list-style-type: none"> <li>➤ Weeding and supervision for any disease incidence</li> <li>➤ Drenching the seedlings with fungicides depends on severity of disease incidence</li> <li>➤ Resowing in ungerminated polybags when rains subsided</li> <li>➤ Watering depends on intensity of rain</li> <li>➤ Ensure proper drainage in the nursery</li> </ul>	<ul style="list-style-type: none"> <li>➤ Removal of emerging shoots from the main stem</li> <li>➤ Soil bunding and anchoring the young seedlings</li> <li>➤ Supervise for the condition of drainage channels. Channels blocked with muddy soil and plant wastes should be cleaned</li> <li>➤ Formation pruning in young seedlings and grafted plants</li> <li>➤ Cutting and incorporating green manure crop in basins</li> </ul>	<ul style="list-style-type: none"> <li>➤ Improve the sanitation in the garden by removing fallen fronds of the main crops coconut/ arecanut, over-ripe, rotten pods, broken branches etc.</li> <li>➤ Slight pruning may be done to ensure sunlight and aeration in the garden</li> <li>➤ Need based plant protection</li> <li>➤ Harvesting continued</li> <li>➤ Look out for aphids, leaf eating caterpillars and cherelle wilt both in young and old seedlings</li> </ul>

***Drenching with fungicide***



***Formation pruning***



***Pruning***





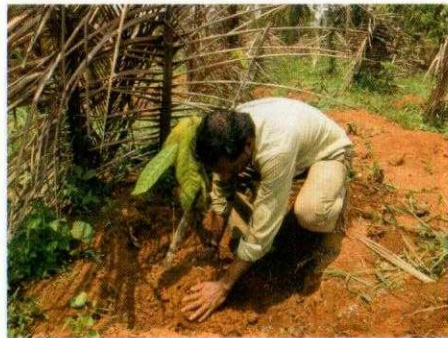
## SEPTEMBER

Nursery	Young garden	Old garden
<ul style="list-style-type: none"> <li>➤ Weeding and supervision for any disease incidence</li> <li>➤ Watering depends on continuity of rain</li> <li>➤ Grafting in May sown 4 months old rootstocks</li> <li>➤ If harvest extended with little rain sowing can be taken up in nurseries which are in operation throughout the year</li> <li>➤ Rootstock preparation to ensure grafting during December, followed by planting during May</li> </ul>	<ul style="list-style-type: none"> <li>➤ Planting at the end of monsoon in high rainfall areas</li> <li>➤ Soil bunding and anchoring the young seedlings, mulching and shading</li> <li>➤ Before sunhemp plants start flowering, cut and incorporate in the basins</li> <li>➤ Regular removal of chupons and weeds</li> <li>➤ Training in young plants and structural pruning</li> </ul>	<ul style="list-style-type: none"> <li>➤ Forking and fertilizer application (second dose)</li> <li>➤ Pruning in matured trees both structural and sanitary pruning after main harvest</li> <li>➤ Cut ends should be pasted with Bordeaux paste to avoid fungal infection with intermittent rains and sunshine.</li> <li>➤ Plant protection</li> <li>➤ Harvesting continued</li> </ul>

**Grafting**



**Soil bunding and anchoring**



**Swabbing Bordeaux paste**





## OCTOBER

Nursery	Young garden	Old garden
<ul style="list-style-type: none"> <li>➤ Weeding and supervision for any disease incidence</li> <li>➤ Watering depends on intensity of rain</li> <li>➤ Grafting in May sown rootstocks</li> <li>➤ Arranging successful grafts and discarding dead ones</li> <li>➤ Removal of polythene pouch covered over graft joint</li> </ul>	<ul style="list-style-type: none"> <li>➤ Planting season in north eastern Tamil Nadu</li> <li>➤ Pruning</li> <li>➤ Soil bunding and anchoring the young seedlings</li> <li>➤ Forking and fertilizer application (second dose if not applied during September)</li> <li>➤ Banana suckers can be planted during this season in a new garden to ensure shading for young seedlings to be planted during forthcoming May</li> </ul>	<ul style="list-style-type: none"> <li>➤ Plant protection</li> <li>➤ Scything and weeding</li> <li>➤ Harvesting continued</li> </ul>

***Removal of polythene pouch***



***Fertilizer application***



***Spraying for TMB***





## NOVEMBER

Nursery	Young garden	Old garden
<ul style="list-style-type: none"> <li>➤ Weeding</li> <li>➤ Watering depends on intensity of rain</li> <li>➤ Plant protection</li> </ul>	<ul style="list-style-type: none"> <li>➤ Installation of drip lines and tubes</li> <li>➤ Irrigation once in a week</li> <li>➤ Soil bunding and anchoring the young seedlings</li> <li>➤ Mulching may be done in young cocoa plantations with cocoa or coconut husk/ fallen cocoa leaves/ pruned twigs</li> <li>➤ Removal of pruned branches from tree basins and plots</li> </ul>	<ul style="list-style-type: none"> <li>➤ Rat and squirrel control</li> <li>➤ Weeding in plantation</li> <li>➤ Removal of big pruned branches from plots</li> <li>➤ Mulching with pruned branches and leaves</li> </ul>

***Weeding***



***Mulching with cocoa leaves***



***Mulching with pruned branches***

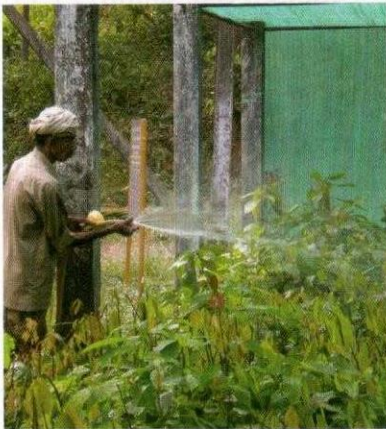




## DECEMBER

<b>Nursery</b>	<b>Young garden</b>	<b>Old garden</b>
<ul style="list-style-type: none"> <li>➤ Weeding</li> <li>➤ Daily watering</li> <li>➤ Grafting may be taken up in September sown rootstocks</li> <li>➤ Shade net covering in the nursery</li> </ul>	<ul style="list-style-type: none"> <li>➤ Irrigation once a week, drip daily basis</li> <li>➤ Chupons removal</li> <li>➤ Plant protection</li> <li>➤ Weeding</li> </ul>	<ul style="list-style-type: none"> <li>➤ Controlled pollination may be taken for hybrid seed production as flowers will be available</li> <li>➤ Removal of chupons, dead woods and dried cherelles</li> <li>➤ Control for pests</li> </ul>

***Watering to grafts***



***Drip irrigation***



***Pollination***





## COST OF CULTIVATION OF COCOA

Estimated cost of cultivation of cocoa when grown as a mixed crop in arecanut garden		
Sl.No.	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
	<b>Annual production of cocoa</b>	<b>650 kg/ha</b>
	<b>B:C Ratio</b>	<b>1: 2</b>



### Cost of operations- man days-for 500 plants

Sl. No.	Operation	1 <sup>st</sup> year (man days)	2 <sup>nd</sup> year (man days)	3 <sup>rd</sup> year (man days)	Total
1	Land cleaning & Peg marking (500 pits)	15	-	-	15
2	Digging pits	30	-	-	30
3	Pit filling, planting, staking, mulching, shading	15	10	-	25
4	Weeding twice a year	10	10	10	30
5	Pruning and training	10	10	10	30
6	Soil working	5	5	5	15
7	Application of manures and fertilizers	10	10	10	30
8	Plant protection-spraying	5	5	5	15
9	Irrigation	10	5	5	20
10	Fencing, watch & ward	5	5	5	15
11	Miscellaneous operations- removal of chupons, cherelles, diseased pods, transportation of inputs	5	10	10	25
	<b>Total</b>	<b>120</b>	<b>70</b>	<b>60</b>	<b>250</b>
	Wages @Rs.200/- per man/day	24,000	14,000	12,000	50,000



## Persons to be contacted for planting materials & details

1. Head, ICAR- CPCRI, Regional Station, Vittal- 574 243, Karnataka
2. Professor & Head, KAU-Cadbury Cocoa Research Project, College of Horticulture, Vellanikkara, Thrissur- 680 656, Kerala.
3. Director, Directorate of Cashewnut and Cocoa Development (DCCD), Ministry of Agriculture and Farmers Welfare, Kera Bhavan, Cochin- 682 011, Kerala.

## Manufacturers

1. Managing Director, CAMPCO LTD, P.B.No.223, 'Varanashi Towers', Mission Street, Mangalore- 575 001, Karnataka/ CAMPCO Chocolate Factory, Kemminje, Puttur.
2. Managing Director, NESTLE INDIA LTD, DLF centre, Sansad Marg, New Delhi- 110 001.
3. Managing Director, CADBURY (MONDELEZ) INDIA PVT LTD, 19 B, Desai Road, Mumbai- 400 026.
4. Mondelez India Foods Limited (Formerly Cadbury India Limited), Sennakkalpalayam, Dhalavaipattinam PO., Dharapuram 638 672, Tamil Nadu. Phone: 04258- 257237/ 257537.
5. General Manager, CORP. Affairs, HINDUSTAN LEVER LTD, 203, Mohta Building 4, Bhikaji Cama Place, New Delhi.
6. General Manager, Tech., BRITANNIA INDUSTRIES LTD, 33, Lawrence Road, Delhi- 110 035.

## Acknowledgements

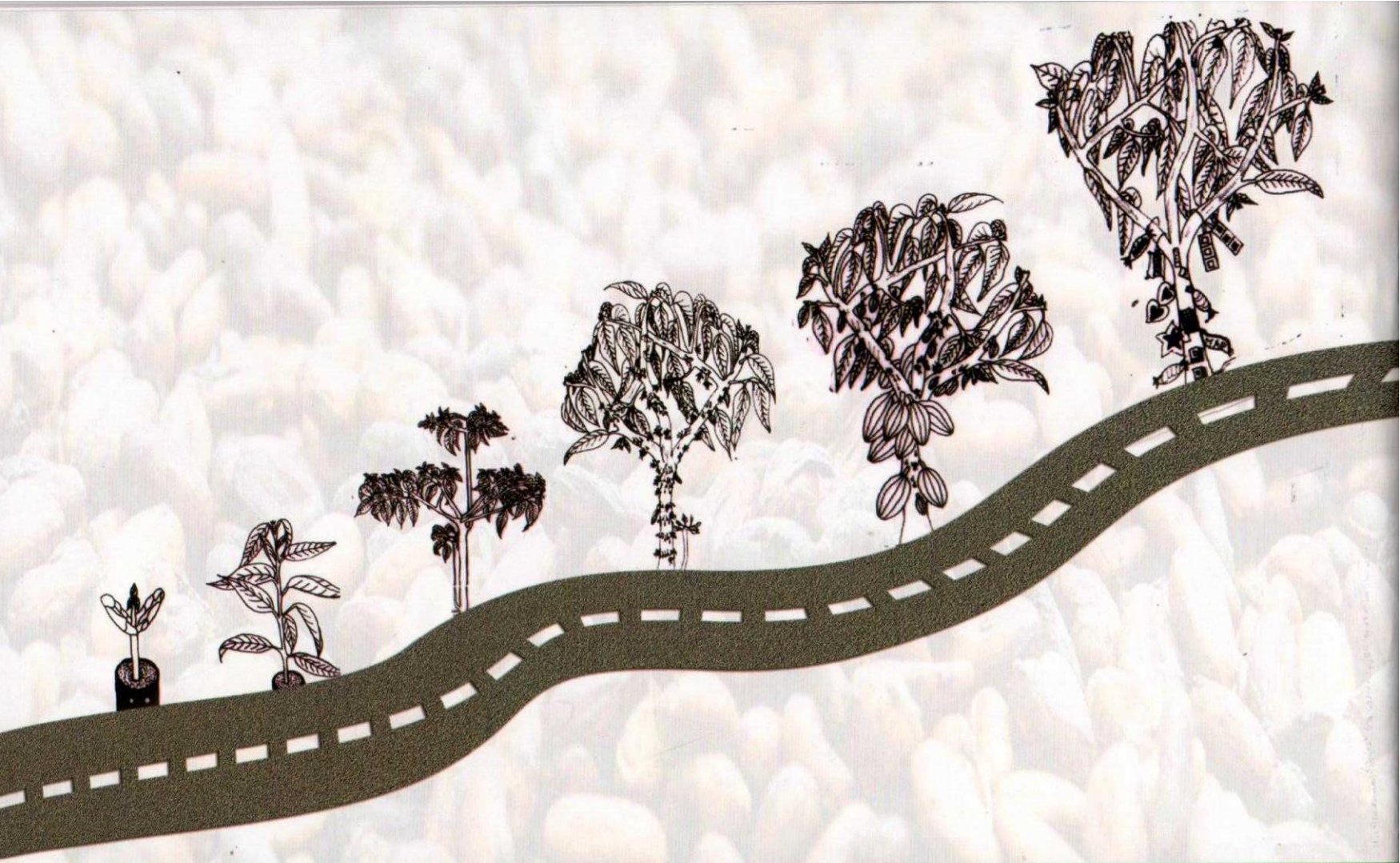
1. DCCD-Directorate of Cashewnut and Cocoa Development, Cochin, Kerala.
2. CAMPCO- Central Arecanut and Cocoa Marketing and Processing Co-operative Limited.
3. KAU-CCRP- Kerala Agricultural University- Cadbury Cocoa Research Project.
4. Mondelez/ Mars International
5. Er. V. J. Prasad, Ramu Farms, Sethumadai road, Pollachi, Coimbatore, Tamil Nadu.
6. Wood & Lass- Cocoa book





### **Contact Address**

The Head,  
ICAR- CPCRI, Regional Station, Vittal, Bantwal Taluk, Dakshina Kannada District, Karnataka- 574 243, India.  
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