COCOA NOTEBOOK

ICAR- CENTRAL PLANTATION CROPS RESEARCH INSTITUTE- CPCRI
REGIONAL STATION, VITTAL - 574 243, KARNATAKA

Technical bulletin No.: 144

Cocoa Note Book

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Printed at

December, 2019

- **Cocoa** (*Theobroma cacao* L.) called as 'Food of Gods'. Important beverage/ industrial/ plantation crop.
- **Area in India:** 82,940 Hectares Production: 18,920 Tonnes
- **Main Cocoa Growing States:** Kerala, Karnataka, Tamil Nadu & Andhra Pradesh.
- **Growing Zones:** Western Ghats Hills and Plains, Palm based Cropping Systems of Humid Tropics, Irrigated Arecanut, Coconut and Oil Palm Gardens, Lower hills with forest and fruit trees as permanent and temporary shades.

CLIMATE

- **Latitude:** 20^{0}N 20^{0}S
  Main growing area 10^{0}N 10^{0}S
- **Elevation:** 500m MSL.
  best up to 300m MSL.
- **Rainfall:** 90-100 mm/ month
  1500-2000 mm/ year
  Give Supplementary irrigation during rainless periods
- **Temperature:** 15-39^{0}C,
  Optimum 25^{0}C.
- **Humidity:** 85-90%

Cocoa at CPCRI Centres

Vittal: 73-90m MSL
Kidu: 290m MSL
NE centres: 50-91m MSL

SOIL

- **Soil type:**
  Deep well-drained soil,
  Clay loam, sandy loam, laterite.
- **Soil pH:** 4.5-8.0, Optimum 6.5-7.0.
- **Ideal soil:** 1.5m depth, 3.5% organic matter, >9 C:N ratio.

SHADE

- **50% shade and 50% sunlight**
- Partial shade under arecanut, coconut and oil palm gardens and forest trees.
- Initial years (10-12 years) shade requirement for cocoa is more.
- Leaves provides self shading effect in old trees.

CRIOLLO TYPE

Fine Cocoa

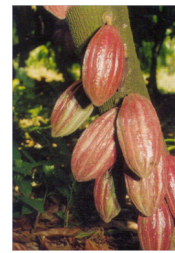
Pod colour	Red to Orange
Pod shape	Thin wall, rough surface, Angoleta shape
Bean colour	White, Plumpy, Round
Bean no.	20-30/pod
Fermentation	3 days
Flavour	Bland & Pleasant
Vigour	Less vigorous
Adaptability	Lesser, susceptible to pests & diseases

FORASTERO TYPE

Basic/ Bulk Cocoa

Pod colour	**Green to Yellow**
Pod shape	**Melon shaped, smooth surfaced**
Bean colour	**Purple, Flat**
Bean no.	**30 or more**
Fermentation	**6 days**
Flavour	**Harsh & Bitter**
Vigour	**More vigorous**
Adaptability	**Wider, tolerant to pests & diseases**

TRINITARIO TYPE



Natural Hybrid of Criollo & Forastero

Pod colour	Mixtures of Green, Red and Purple
Pod shape	Thick & thin wall, smooth surface, mixture of shapes
Bean colour	Variable in colour
Bean no.	30 or more
Fermentation	Intermediate/ 6 days
Flavour	Mixture
Vigour	Intermediate
Adaptability	Wider, tolerant to pests & diseases

COCOA VARIETIES

VTLCH 1 (Vittal Cocoa Hybrid 1)

- Heavy bearer, adapted well
- Dry bean yield / tree / year- 1.48 kg/16 m^2 canopy

VTLCH 2 (Vittal Cocoa Hybrid 2)

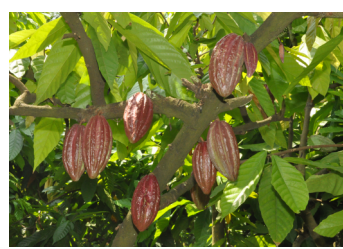
- High yielder, tolerant to black pod rot
- Dry bean yield/tree/year-1.15 kg/15 m^2 canopy

VTLCH 3 (Vittal Cocoa Hybrid 3)

- Suitable for water limited conditions
- Dry bean yield/tree/year -1.45 kg / 18m^2 canopy

VTLCH 4 (Vittal Cocoa Hybrid 4)

- Suitable for water limited conditions
- Dry bean yield/tree/year -1.25 kg/18 m^2 canopy



VTLCC 1 (Vittal Cocoa Clone 1)

- Self and cross compatible clone
- Dry bean yield/tree/year-1.33 kg/12 m^2 canopy

VTLCS 1 (Vittal Cocoa Selection 1)

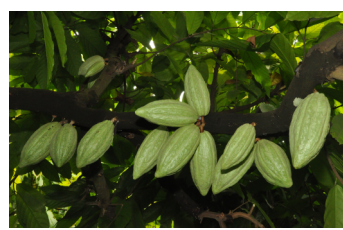
- Suitable in coconut/arecanut gardens
- Dry bean yield/tree/year-2.70 kg/15 m^2 canopy

VTLCS 2 (Vittal Cocoa Selection 2)

- Suitable in coconut/arecanut gardens
- Dry bean yield/tree/year-2.52 kg / 15 m^2 canopy

VTLCH 5 (Vittal Cocoa Hybrid 5)

- Suitable for high density planting
- Dry bean yield/tree/ year-2.5-3.0 kg/16-17 m^2 canopy

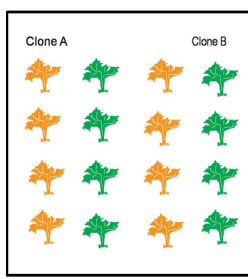


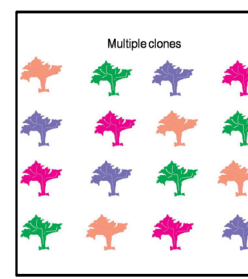
Grow multiple varieties to overcome the problem of incompatibility

SEED GARDEN

Bi Clonal Orchard: Assembled with two self incompatible but cross compatible parents to produce hybrid of particular variety of known parentage and performance.

Poly Clonal Orchard: Assembled with multiple self incompatible but cross compatible parents to produce hybrid of mixed varieties.





COCOA NURSERY

- **Mother trees:** Forasteros & Trinitarios
- **Pod yield in mother trees:** 50-100 pods/tree/year after 6 years and upto 12 years.
- **Seed pod:** 350 g weight with smooth or shallow surface without neck, Husk thickness of 1cm, >35 bold beans from the middle portion of the pod.

- **Polybag nursery:**
  Black polybags of 6″x 9″ size,
  250 gauge thickness with 9 drain holes
- **Potting mixture:**
  2:1:1 Soil: Sand: FYM (Farm Yard Manure/ any composts).
- **Sowing:**
  Open pods & sow seeds immediately after removing mucilage (Shallow horizontal sowing).
- **Planting:** - Use 4 months old seedlings.

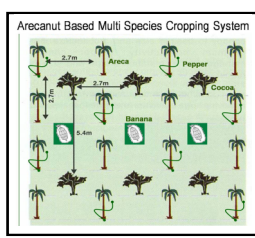
PLANTING SYSTEMS

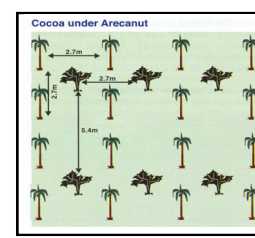
UNDER ARECANUT

- Arecanut: 2.7 m x 2.7 m (9 ft x 9 ft)
- Cocoa in centre of four areca palms at 2.7 m x 5.4 m (9 ft x 18 ft) spacing
- 686 plants / ha
- An equal spacing of 3 m x 3 m for arecanut & cocoa and same time planting is recommended for new plantations.

ARECANUT BASED MULTI SPECIES CROPPING SYSTEM

- Arecanut: 2.7 m x 2.7 m
- Cocoa / Banana / Pepper: 2.7 m x 5.4 m





UNDER COCONUT

- Coconut: 7.5 m x 7.5 m (25 ft x 25 ft)

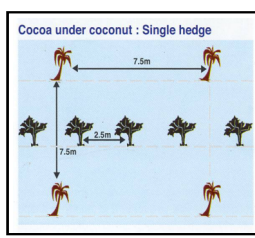
Single Hedge System:

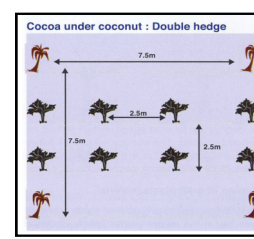
Cocoa in centre of two rows of coconut at

- 3 m x 7.5 m (10 ft x 25 ft) = 444 trees/ha

Double Hedge System:

- 2.5-2.7 m (8 ft x 9 ft) = 800 trees / ha
- 2 m away from palm basin to avoid damage due to fallen fronds
- 3 m between cocoa is advised in widely spaced coconut gardens.



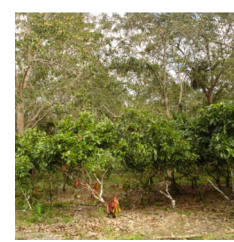


UNDER OILPALM

- Oil palm: 9x9x9 m triangular planting
- Cocoa: 2.5-3 m = 400 plants/ha
- Cocoa at 2 m away from palm basin.
- >15 years old oil palm at square system of planting is good to avoid heavy shade.

UNDER TREES
(*Glyricidia/ Erythrina/ Sesbania*)

- Shade trees: 8-9 m spacing
- Cocoa to cocoa: 3 m x 3 m



PLANTING

- Pit size: 60 cm^3 (2 ft), take pits 2-3 weeks before planting to ward off the field heat.
- Fill the pits half with top soil and 5 kg Farm Yard Manure (FYM) or any compost one week before planting.
- Fill the pit with bottom soil and plant the seedling at the centre.
- Stake the seedlings with 2.5 ft long stakes to give support upto 2 years.
- In case of clones, graft joint should be above the soil surface.
- Shade the seedlings with coconut leaves.
- Give life irrigation, if not rained.
- High rainfall zone- post-monsoon planting - August - September.
- Low rainfall zone- monsoon planting- May - June.

FERTILIZER SCHEDULE

- **First dose:** April- May (Pre-monsoon)
- **Second dose:** September-October (Post-monsoon)
- Additional potassium in split doses to get more dry bean yields.

Fertilizer (g/plant/year)	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
Shallow basins	1 ft	2.5 ft	3 ft

IRRIGATION

- **Flood/ furrow irrigation:**
  Once in five days, 175 litres of water
- **Drip irrigation:**
  20 liters of water/ day/ tree.
- **Fertigation:**
  Urea- 107 g
  Diammonium Phosphate (DAP) - 145 g
  Muriate of Potash (MOP) - 180 g

COCOA PRUNING

Pruning in cocoa is necessary

- To decide height of first jorquette, no. of jorquettes/tree, no. of fans/jorquette.
- To maintain medium tree size, cone/umbrella shaped canopy architecture.
- To induce flowering & efficient fruiting.

Formation pruning in young plants :

- Adujsts first branching height to 1 m.
- Allows 4 fan branches in 4 directions North, South, East & West.
- Maintains single tier canopy.
- It helps to remove chupons.
- Remove chupons / upward growing orthotropic shoots / hanging branches.

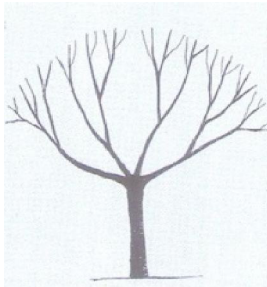
Structural pruning in old trees :

- Canopy spread of 3.8-4.0 m and height 2.7 m under arecanut / coconut.
- Annual pruning- September.

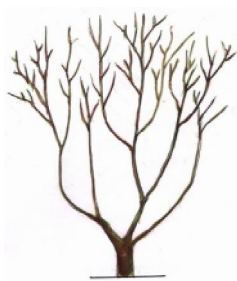
Sanitary pruning :

- Remove diseased, dead shoots, rotten, rodent damaged pods, epiphytes, climbers, ant nests.

SEEDLING TREE



CLONAL TREE



COCOA DISEASES AND DISORDERS

SEEDLING DIEBACK/ BLIGHT

Symptoms: Drying & dying of sprouts from tip; internal vascular discoloration, yellowing, blight.

Management: Remove & destroy infected seedlings & improve drainage facilities.

- Solarise potting mixture in sun and cover with black polythene sheet for 1 month.
- Bio-prime with 2.5 g Cocoa Probio or *Trichoderma harzianum* (isolate CPTD-28) microbial culture per kg seed.
- Drench with Bordeaux mixture (1%) or Copper Oxychloride (2.5 kg./L of water) before monsoon. Repeat at 15 days intervals.

CHERELLE WILT/ ROT

Physiological wilt: Yellowing, browning and blackening of young cherelles / small developing pods.

- It is a natural thinning mechanism at 25, 50, 75 days of fruit set.
- Manual removal of wilted cherelles helps developing pods to gain size.

Pathological wilt: *(Colletotrichum gleosporioides)*

- Small water soaked lesion at stalk end, sunken spots with diffused yellow halo, mummification of cherelles.
- Spray Carbendazim @0.05% or Mancozeb @0.2%

CHARCOAL POD ROT

(*Lasiodiplodia theobromae*)

Symptoms:

- Infection starts as dark brown spot, turns black and remains as mummified fruit on the tree.
- Internal tissues become rotten and affected beans turns black.
- Severe during summer months.
- Pods of all ages are susceptible.

Management:

- Spray Bordeaux mixture (1%).

BLACK POD DISEASE OR POD ROT
(Phytophthora spp.*)*

Symptoms:

- Small circular water soaked lesion on pods turns to dark brown spot.
- Within 14 days of initial infection, entire pod turn to black colour.
- Black pod disease occurs during south west monsoon season.

Management:

- Removal & destruction of infected pods; maintain field sanitation.
- Prune branches to get more sun light on main stem and branches.
- Spray Bordeaux mixture @ 1% at 45 days interval.

STEM CANKER (*Phytophthora* spp.)

Symptoms:

- Appearance of dark brown, round to oval shaped discolored area on the bark.
- Oozing of reddish brown liquid.
- Yellowing, wilting of leaves & shoots followed by death of plant.

Management:

- Phytosanitation, removal and destruction of black pods.
- Avoid trunk covering or mulch near main stem, clean the basin.
- Provide drainage facility in garden.
- Proper pruning twice in a year- structural and sanitary pruning.
- Early stage- remove infected tissues and apply bordeaux paste.
- Long term management- wound treatment with *Trichoderma* coir pith cake and soil application.

VASCULAR STREAK DIEBACK (VSD)
(*Ceratobasidium theobromae*)

Symptoms:

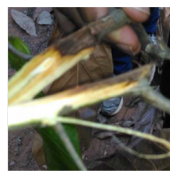
- **Typical yellowing of one or two leaves of 2nd or 3rd flush behind shoot tip.**
- **Affected leaf dries, falls off, youngest and oldest leaves will remain intact.**
- **Cut opened stem will show long longitudinal brown streak, due to infection of xylem vessels.**

Management:

- Uprooting and burning of severely infected plants.
- Pruning of infected leaves, branches, 30-40 cm below the end of visible brown streaking.
- Swab the cut ends with Bordeaux paste (10%).
- Prophylactic spray - Bordeaux mixture @1% or Copper oxychloride @0.25% twice in a year during May-June and October months.
- Soil drenching with 0.25% Copper oxychloride (2.5 kg / litre of water).

COCOA DIEBACK
(*Lasiodiplodia theobromae)*






Symptoms:

- Yellowing of leaves, drying in particular pattern from tip of the twigs to main stem as die back symptom.
- Cross section of affected branches shows dark brown colour necrotic areas advancing from tip to base.
- Drying of all branches, whole canopy and death of plant.

Management:

- Periodic surveillance to identify the disease in early stage of yellowing.
- Trimming & pruning of affected branches to prevent the spread of the disease.
- Disinfect pruning knives and harvesters to prevent carrying pathogen to healthy plants.
- Swab the cut ends with Bordeaux paste (10%) to ensure protection.
- Prophylactic spray of Bordeaux mixture 1% to healthy plants surrounding the diseased ones.
- Emergence of new flushes from the collar region and chupons from the basal portion of a dead trees are observed.
- If not, the dead trees to be uprooted, discarded away from plot and burnt.

ZINC DEFICIENCY

Symptoms:

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

Management:

- Spray 0.3% Zinc Sulphate as foliar application.

IRON DEFICIENCY

Symptoms:

- Darker green veins in younger leaves against a paler green background.
- Green tinted veins against pale yellowis-white or almost completely white background and tip scorching.
- Narrow marginal and tip scorching in older leaves.

Management:

- Spray 1% aqueous Ferrous Sulphate solution repeatedly.

BORDEAUX MIXTURE

Preparation of 1% Bordeaux mixture

- Dissolve 1 kg Copper Sulphate crystals in 10 litres of water in a plastic container.
- Dissolve lime (Quick Lime- 750-850 g; Hydrated Lime- 375-450 g) in 10 litres of water in another plastic container.
- Pour both solutions simultaneously to 80 litres of water with constant stirring.
- Dip pH paper in the solution and if it turns blue, the mixture is neutral with 7.0 pH. (or)
- Dip a well polished knife or sickle, if the blade shows reddish colour, add lime to the mixture till the blade does not show staining.
- Wetting agent at 1ml/ litre can be added to Bordeaux mixture before spraying.
- Spray effectively with a mist nozzle.

Precautions

- Fresh Bordeaux solution should be prepared always in a earthen (or) wooden (or) plastic containers.
- Prepared mixture should be sprayed within 4-5 hrs.
- At the time of preparation and spraying proper stirring is required.
- Don't add hot water.
- 1% Bordeaux mixture is recommended twice as prophylactic spray.
- First spray during pre-monsoon showers and second spray after 40-45 days of first spray in coconut, arecanut and cocoa orchards for *Phytophthora* disease management.
- Spray effectively with a mist nozzle.

BORDEAUX PASTE

Preparation of 10% Bordeaux paste

- Dissolve 100 g Copper Sulphate and 100 g Quick Lime each in 500 ml of water separately.
- Mix thoroughly to get a paste.
- Swab Bordeaux paste in cut ends of pruned branches of cocoa and also in the coconut / arecanut crown portion after removing the diseased spindle leaves.

COCOA PESTS

APHIDS
(*Toxoptera aurantii*)

Symptoms:

- **Aphids colonize terminal /growing shoots causing leaf deformation and curling of leaves during summer.**
- **Colonize on a succulent stem, flower buds, small cherelles causes premature shedding.**

Management:

- **Many natural enemies feed on aphids and exert natural check.**
- **If infestation is severe, spray Imidacloprid (17.8 % SL) at 0.3 ml / L as a spot application.**

TEA MOSQUITO BUG (TMB)
(*Helopeltis* spp.)

Symptoms:

- Infestation starts in young flushes developed after pruning, in October, then in small cherelles and pods.
- Feeding spot appear as dis-coloured necrotic and darker lesion.
- Circular lesions are externally visible as hardened scars on the plant parts.

Management:

- Shade regulation through proper pruning and training of cocoa plants.
- Removal of alternate hosts like neem, cashew, guava from the surroundings.
- Less infestation: Spray *Beauveria bassiana* @ 4g/ L of water or neem oil @ 3%.
- Persistent infestation: Repeat spray at 20 to 30 days interval.
- Severe infestation: Spray any one of the following insecticides *viz.,* Lamdacyhalothrin 5 EC (0.003%) 0.3 ml/ L (or) Imidacloprid 17.8 SL (0.004%) 0.25 ml / L.
- One spray each during flushing, flowering and fruiting times.
- Spray during morning hours.

MEALYBUG
(*Planococcus lilacinus and P. citri)*

Symptoms:

- Nymphs and adult females occur in colonies in summer and infest growing shoots, foliage, terminal buds, flower stalks, pods by sucking the sap.
- Seedlings colonized by mealybugs. show retarded growth and excessive branching at undesired height.
- Tender leaves deform into hair-like structures, affects flower development.
- Cherelles and young pods dry up.
- Reduction in size and vigour of pods in severely affected gardens.

Management:

- Conservation of lady beetles *Pullus* spp., *Lycaenid*, *Spalgius epius* encourage bio-suppression of mealybugs.
- On the incidence of *Paracoccus marginatus,* field release parasitoid *Acerophagus papayae* @ 100/ hamlet.
- Spot application on the pest colony with 0.5% neem oil emulsion along with 5% soap solution two-times at fortnightly intervals .
- Spray with biorational molecules like Insect Growth Regulators (IGRs), such as Buprofezin, if the population is high.
- Need-based application of insecticides such as Imidacloprid (17.8% SL) at 0.3 ml/ L of water or Dimethoate 30 EC at 1.6 ml/ L of water.

STEM BORER
(Rhaphipodus subopacus)



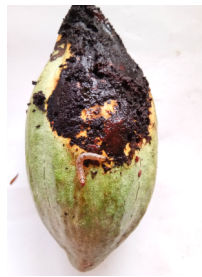
Symptoms:

- **Grubs tunnel the bark and penetrate deeper by making zig-zag galleries.**
- **Younger trees: Infestation occurs at the jorquette, results in drying or breaking of the portion above.**
- **Older trees: Attack in main stem or trunk region causes yellowing, browning of leaves and death of plants.**
- **Infestation is severe where cocoa is planted in forest cleared tracts or near forest zones or unmanaged plots.**

Management:

- Mechanical collection of grubs from affected branches with a iron spike the or needle stick and destruction.
- Clean the webs, excreta and plug the holes with cotton wool soaked with Chloroform, Formalin or Petrol and seal it with mud.
- Place Chlorpyriphos 0.05% soaked cotton and wrap it with polythene tape.
- Swab Coal tar + Kerosene @1:2 in the basal portion of the trunk at 3 feet height after scraping the loose bark to prevent laying eggs by adults.
- Maintain farm sanitation. Avoid over crowding of trees.
- Cut and burn the dead and severely affected branches.
- Avoid piling or dumping too much pruned branches and weeded grass in the tree basin.

COCOA FRUIT BORER
(*Conogethes punctiferalis*)



Symptoms:

- Minor pest became key pest with climate change effect.
- Caterpillars feed on rind/ husk of the cocoa pods, bore, feed the internal contents, extruding granular fecal pellets.
- Found in most cushion bearing trees where the pods are too compact.

Management:

- Collect and destroy infested pods.
- Plant castor as a trap crop in borders.

RED BANDED THRIPS
(*Selenothrips rubrocinctus*)

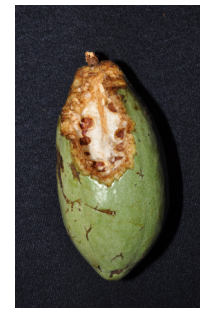
Symptoms:

- Adults and nymphs appear in colonies on the under surface of the leaves and pods.
- Infested leaves turn pale green to pale brown and dry up later.
- Thrips feed on the fluid exuding from the scraped tissues and appear as brown streaks and patches on pods.

Management:

- Apply Imidacloprid (17.8% SL) at 0.3 ml/ L of water.

RATS
(*Rattus rattus*)



Symptoms:

- Rats gnaw the pods near the stalk.
- Rats damage both the mature and immature pods.

Management:

- Keep 10 g Bromadiolone (0.005%) wax cakes on the branches of cocoa trees twice at an interval of 10-12 days.
- Rat traps with fried coconut pieces can be used.

SQUIRRELS

(*Funambulus tristriatus and F. palmarum*)

Symptoms:

- Squirrels gnaw the pods in the center, damage the mature, ripe pods and eat the sweet mucilage/ beans.

Management:

- Trap with wooden or wire mesh single catch 'live' trap with ripe coconut kernel as the bait.
- Trap during lean periods (October-November), when alternate foods like paddy, cashew apples, mangoes and jackfruits are not available.
- Timely harvest of pods and proper plant density increases the efficiency of baiting and trapping.

COCOA PROCESSING

HARVESTING

- **Cocoa flowering:** 2nd year in clones, 4th year in seedlings.
- **Main flowering:** November- December in Karnataka.
- **Fruit development:** January- April, matures in 135-170 days.
- **Stage of maturity:** pod colour changes from Green (unripe) to Yellow (ripe) and from Red (unripe) to Orange (ripe).
- Depending on management, cocoa tends to yield through out the year.

Kerala/ Karnataka	May-Aug- main harvest Oct-Dec- second harvest
Tamil Nadu	Jun-Jul- main harvest Nov-Jan- second harvest
Andhra Pradesh	Jan-Jun- main harvest Jul-Dec- second harvest

- **Maturity stage of pods and timely harvests are crucial for processing.**
- **Under-ripe pods affect quality, Over-ripe pods show vivipary.**
- **Harvest interval: 10-15 days.**
- **Cut the fruit stalk with a sharp knife.**
- **CPCRI cocoa harvester- with light weighted telescopic pipe, two-sided sharp blades can be used.**
- **Heap and keep the harvested pods in shade for 3 days to enhance pre fermentation activity.**
- **Sort and discard diseased and damaged pods.**

- Break open the pods with wooden hammer or carefully with a knife without damaging beans.
- After the crosswise opening of pods, collect beans and discard husk along with placenta.
- Fresh husk can be used as cattle feed and composted for use as a component in the potting mixture. Husk is rich in potassium.
- Each pod will have 25-45 beans embedded in white pulp or mucilage which is important for fermentation.

FERMENTATION

- Removes adhering mucilaginous pulp,
- Kills the germ of the seed,
- Loosens the testa,
- Develops brown color, chocolate flavour and aroma precursors and
- Reduces bitterness of beans.

During fermentation process

- Beans are covered with banana leaves/ gunny bags to generate heat.
- Fermentation takes 6-7 days.
- Mixing/ turning of beans on 3rd & 5th day will ensure uniform distribution of heat.
- Completion: Beans attain a reddish brown colour at the end of 6th day.
- Incomplete fermentation makes the cured beans bitter and astringent.
- On 7th day, beans are taken out for drying.

1. Basket method

- Bamboo/ cane/ baskets made of local vines, 25 x 15 cm height with lid & handle, holds 5-6 kg wet beans.
- Banana leaves placed at bottom to drain sweatings and to cover beans.
- After filling, close with lid, cover with gunny bag and keep a weight over it.
- Change banana leaves during each turnings. Cocoa beans can be processed without banana leaves also.
- Keep basket on raised surface or on a tray to facilitate drainage of sweatings.
- Mixing of beans- 3rd and 5th day.

2. Box method

- **Wooden box- 45 cm length x 30 cm width x 20 cm height with drain holes to allow the sweatings to flow out.**
- **Fermentation box holds 13-15 kg wet beans.**
- **After filling, close tightly with lid.**
- **Mixing on alternate days, to facilitate uniform fermentation, to maintain proper temperature, moisture and aeration.**
- **Temperature of fermented mass rises to 42-48°C after 48 hours.**
- **A minimum of 6 days (144 hours) required to complete fermentation process.**

3. Mini tray method

- Wooden trays or plastic crates of 45 cm length x 30 cm width x 15 cm height with drain holes can be used.
- About 10 kg wet beans are filled in these trays, leveled and covered.
- Multiple trays can also be staked one above the other, if the quantity of beans are more.
- Fungal infection is less in these trays and easy to wash for the next usage.

4. Gunny bag method

- For a small quantity of beans clean gunny bags, cloth bags and polythene lined bags can be used.
- Beans are filled loosely in bags and allowed to drain sweatings for 1 day.
- Gunny bags are heaped one over the other and covered properly to conserve the heat.
- Beans are mixed without opening the bag on 3rd and 5th day by rolling.
- In this method, beans tend to get more fungal infection and so care should be taken while mixing.

DRYING

Fermented cocoa beans have 55-69% moisture which has to be brought down to 6-7% by drying.

Sun-drying: Sun-drying gives superior quality produce.

- **Spread fermented beans on a bamboo mat / cement floor / polythene sheet for 5-6 days.**
- **Do timely turning for uniform drying and to prevent clogging.**
- **Properly dried fistful of beans when compressed in palm produce cracking sound.**
- **Sun-drying is widely practiced in TN & AP, where humidity and rainfall is less.**

Artificial drying

- During monsoon, artificial drying to be adopted in Kerala and Karnataka.
- Partially enclosed solar dryers could attain high temperature quickly, rate of drying is faster (3-4 days) and give better quality produce.
- Poly house / Glasshouse can be used for drying beans.
- Duration of artificial drying varies from 48-96 hrs (2-4 days) with 50^{o}C.
- Very high temperature should be avoided to reduce the burnt smell.
- Slow drying in the initial stage will give better quality beans.

Electric oven

- Oven drying is practiced in research institutes.
- Beans have to be dried for 8-10 hours at 50-55^0 C for the first two days, followed by continuous drying at 60^0 C.
- Total drying period- 72-96 hrs (3-4 days).
- Beans are to be mixed at regular intervals for uniform drying, to prevent clump formation and to avoid breakage of beans.
- While shelling, whole beans are expected by proper drying.
- Properly processed and dried beans will have more fat content for chocolate making.

Grading and storage

- Dried cocoa beans after cooling to room temperature are cleaned before storage.
- Flat, slaty, shriveled, broken, mouldy beans and other extraneous materials are to be removed.
- Cleaned beans are packed in fresh polythene- lined (150-200 gauge) gunny bags.
- Bags packed with dry beans are kept on a raised platform of wooden planks.
- Rooms should be free of spices, pesticides and fertilizer to avoid absorption of odour
- Beans should be stored in humid free environment to avoid fungal infection as well as storage pests.
- Properly cured and dried beans can be stored from 3-6 months.

Yield potential:

- Under normal cultivation conditions as a mixed crop under palms, each cocoa tree is expected to yield 1 kg dry beans annually.
- Under arecanut with a spacing of 2.7 m x 5.4 m, one hectare accommodates 686 trees with a yield potential of 686 to 1300 kg dry beans with an optimal canopy area of 15-20 m^2.
- Under coconut potential yield upto 3-4 kg is obtained from cocoa trees with two storey canopy.
- Income: Rs. 1.0- 1.4 lakhs per hectare (@Rs. 150- 200/ 1 kg dry beans)

Cost of planting materials

- Cocoa seed pod - Rs. 30/-
- Cocoa seedling - Rs. 10/-
- Cocoa graft - Rs. 30/-

COST OF CULTIVATION

Cost of operations

Sl. No.	Operation
1	Land cleaning & peg marking.
2	Digging pits.
3	Pit filling, planting, staking, mulching, shading.
4	Weeding twice a year.
5	Pruning and training.
6	Soil working.
7	Application of manures and fertilizers.
8	Plant protection- spraying.
9	Irrigation.
10	Fencing, watch & ward.
11	Miscellaneous operations- removal of chupons, cherelles, diseased pods, transportation of inputs, seedling for gap filling.
	Total
	Wages @ Rs.200/- man / day

- Man days for 500 plants.

1st year (man days)	2nd year (man days)	3rd year (man days)	Total
15	-	-	15
30	-	-	30
15	10	-	25
10	10	10	30
10	10	10	30
5	5	5	15
10	10	10	30
5	5	5	15
10	5	5	20
5	5	5	15
5	10	10	25
120	70	60	250
Rs. 24,000	Rs. 14,000	Rs. 12,000	Rs. 50,000

Cost of cultivation under arecanut

Sl. No.	Particulars
1.	Establishment cost during pre-bearing stage (3 years)
2.	Cost of drip system
3.	Total establishment cost including drip system
4.	Annuity value for establishment cost
5.	Annual fixed cost of drip irrigation system
6.	Labour charges for annual maintenance
7.	Input charges for annual maintenance
8.	Total annual maintenance cost during bearing stage
9.	Total cost of cultivation per year with annuity value during bearing stage
10.	Total cost of cultivation per year with annuity value during bearing stage with fixed cost for drip irrigation
	Annual production of cocoa
	B: C Ratio

Cost of cultivation under arecanut

Rs./ Ha
50,000
15,000
65,000
4,800
3,000
13,200
10,000
23,200
28,000
31,225
650 kg/ ha
1: 2

Contact Address

The Head
ICAR- Central Plantation Crops Research Institute- CPCRI
Regional Station, Vittal,
Bantwal Tk., Dakshina Kannada Dt.,
Karnataka- 574 243.
cpcrivtl@gmail.com, Ph: 08255- 239238

Cocoa Promotional Activities

The Director
Directorate of Cashewnut and Cocoa Development (DCCD),
Ministry of Agriculture and Farmers Welfare,
Kera Bhavan, Cochin- 682 011, Kerala.
www.dccd.nic.in

Cocoa Processing and Marketing

Central Arecanut and Cocoa Marketing and Processing Co-operative Ltd. (CAMPCO), Chocolate Factory,
Kemminje, Puttur- 574 202
www.campco.org

COCOA AT A GLANCE

Cocoa	:	Chocolate Tree
Types	:	Criollo, Forastero, Trinitario
Cropping model	:	Palm based mixed cropping system
Economic part	:	Beans
Cropping period	:	35 years
Plant habit	:	Branching in tiers of chupons & fans
Reproductive phase	:	Cushion flowering, cherelles, pods
Pollination	:	Cross pollination
Breeding behaviour	:	Self incompatible & Cross compatible
Main season	:	May- August
Pruning & Flushing	:	September- October
Flowering	:	November- December
Fruit development	:	January- April
Pod/ Dry bean yield	:	50 nos./ 1 kg/ tree/ year
Single bean weight	:	> 1 g
Pod : Bean/ Wet : Dry	:	3 : 1
Shelling	:	10-15%
Nib recovery	:	85-90%
Fat content	:	50%

COCOA NOTEBOOK

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