STRENGTHENING COCOA NURSERY SYSTEMS THROUGH GOOD HORTICULTURAL PRACTICES AND BIOTECHNOLOGICAL STRATEGIES FOR SUPERIOR PLANTING MATERIAL PRODUCTION

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Introduction

Cocoa is a perennial plantation crop and its sustainability depends on the unhindered supply of beans from quality planting materials. Unlike other plantation crops like Tea, Coffee, Rubber, cocoa is grown as a mixed crop under palms and still with small and marginal land holdings, whose productivity needs to be improved. Govt. of India, identified the potential of cocoa and encouraging its area expansion to meet the chocolate industry demand of 60,000 MT as against the current production of 28,000 MT dry beans, for which around 2,20,000 ha needs to be brought under cocoa cultivation. Often cocoa plantings are seen with varieties from single source and single supplier, that too of seedling progenies. Considering the cross pollinated nature and presence of incompatibility in cocoa, strengthening nursery systems with elite clones and hybrids which are tested over multilocations and different cropping models is necessary, Strategies like systematic establishment of mother gardens and maintaining them with good horticultural practices, ensuring the quality of planting materials by following the standards for seeds/ seedlings/ grafts/ budlings etc., scientific plant protection methods and certification of nurseries are very important.

VTLCH 1

VTLCH 2

VTLCH 3

VTLCH 4

VTLCH 5

VTLCC 1

1. Cocoa varieties of ICAR- CPCRI

ICAR- CPCRI with its five decades of research developed five hybrids, VTLCH-1, VTLCH-2, VTLCH-3, VTLCH-4, VTLCH-5 and three clones VTLCS-1, VTLCS-2, VTLCC-1 to be used for cultivation in different cocoa growing regions of Western Ghats Hills and Plains, East Coast Hills and Plains in South and East Himalayan and Terrai regions of North East zone and also under arecanut, coconut and oil palm gardens and agro forestry systems. They are not only high yielders but tolerant to major biotic and abiotic stresses of cocoa growing regions.

VTLCS 1

VTLCS 2

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2. Seed propagation

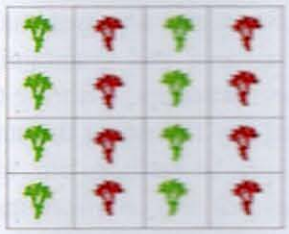
2.1. Selection Criteria for Mother Trees and Seed Pods

To identify suitable mother trees from larger populations of old cocoa trees, especially from traditional zones with local adaptive types, following selection criteria to be considered and to be certified by research institutes.

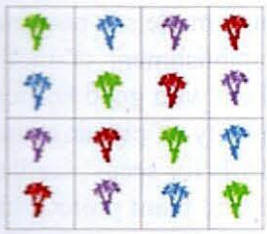
Mother trees	Forastero and Trinitario type of cocoa with green or red pods, free from major pests and diseases
Bearing	Trees bearing 50 pods after six years or 100 pods after ten years. Clonal trees are preferable.
Pod type	Smooth surfaced with shallow furrows without prominent constriction at the neck
Pod size	Medium to large pods of not less than 350 g weight with 120 g wet beans/ pod
Pod value	No. of pods required to produce 1 kg beans to be not >12
Husk thickness	1 cm
No. of beans	>35/ pod
Bean weight	Wet: 3 g, Dry: 1 g and above

2.2. Seed Gardens or Clonal Orchards

Presence of self-incompatibility is observed in many cocoa populations. Self-incompatible but cross-compatible genotypes are widely used for hybrid production. The purpose of seed garden or clonal orchard is to produce seeds of known parentage and proven performance in terms of high yield. 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 but cross-compatible parents they are called as bi-clonal orchards and if planted with multiple clones called as poly-clonal orchards. For example, for production of true hybrid seeds of variety VTLCH-1, parent A and parent B will be assembled in bi-clonal garden established with grafted or budded parental genotypes. It is important to establish such gardens in research institutes, seed farms of state horticulture departments, KVKs etc. and regional nurseries in gardens of progressive farmers or commercial nurseries to meet out the huge demand of seedlings. These should be at an isolation distance of 200-400 m to avoid unwanted crosses. Six bi-clonal and one poly-clonal orchards with parental clones with 1500 trees were established during 1987 and maintained at CPCRI, Research Centre, Kidu, Karnataka for supply of seed pods. A minimum of 1 ha or 500 mother trees are advisable to be assembled in these gardens. Apart from these clonal orchards with parental clones for production of true hybrid seeds, varieties developed through selection breeding are being accumulated in clonal orchards with single variety or multiple varieties also which are utilized for production of clonal seeds as well as vegetative propagules.



Bi Clonal Garden



Poly Clonal Garden

Bi-clonal gardens			Poly-clonal garden
VTLC-11 (I-56)	x	VTLC-30A (NC-42/94)	VTLC-1A (I-14) VTLC-11 (I-56) VTLC-8 (III-105) VTLC-30A (NC-42/94)
VTLC-61 (ICS-6)	x	VTLC-66 (SCA-6)	
VTLC-11 (I-56)	x	VTLC-8 (III-105)	
VTLC-1A (I-14)	x	VTLC-30A (NC-42/94)	
VTLC-1A (I-14)	x	VTLC-11 (I-56)	
VTLC-1A (I-14)	x	VTLC-7 (IV-20)	At CPCRI RC Kidu

Self Incompatible and Cross Compatible Clones at Mother Gardens/ Regional Nurseries	
VTLC-5 (II-67)	VTLC-19A (NC-29/66)
VTLC-7 (IV-20)	VTLC-63 (NA-31)
VTLC-9 (III-35)	VTLC-64 (NA-33)
VTLC-10 (I-21)	VTLC-65 (IMC-67)
VTLC-15A (NC-23/43)	VTLC-69 (ICS-89)

2.3. Seed Pod Harvest and Sorting

- Ten to twelve year old mother trees are used for seed pod collection, if it is of seedling origin and five to six years old in case of clonal trees.
- Cocoa pods take 150-170 days to attain harvest stage after pollination. Correct stage of maturity is assessed from visible change of colour of green pods to yellow and red pods to orange. Generally colour change starts at the furrow of pods. Maturity of pods are being assessed traditionally by making a tap on the pod which gives a hollow sound, which depicts that the beans are detached inside from husk. Immature pods will give poorer seedlings with leaf abnormalities and over ripe pods tend to have viviparous germination.
- Harvesting of seed pods is done with a sharp knife without damaging the flower cushions or the bark as flowering and fruiting in cocoa is **cauliflorous** i.e. truncate bearing. CPCRI developed a cocoa harvester with light weighted telescopic pipe and blades sharpened at both sides, which helps harvesting pods attached compactly in the cushions and the bark.
- Well matured seed pods are broken either by hitting against a hard surface or with a wooden hammer. Gentle cut with knife may be practiced with due care without damaging the seeds. Seeds are to be extracted without placenta.
- For long distance transportation, pods are harvested at third-fourth maturity, they can also be kept for three-four days in the nursery in shade and used.

2.4. Seed Standards, Viability and Seed Treatment

- Seeds/beans in cocoa are **recalcitrant without dormancy** and if the pods are cut open, seeds should be sown on the same day of opening.
- Bold and big beans extracted from middle portion of the pods will give 90-95% germination.
- In the ripe pod, seed is surrounded by a mucilaginous pulp which can be removed by gentle rubbing of seeds with sand or saw dust to speed up the germination.
- In traditional zones, the first harvest starts from the month of April, in which the seeds will have less mucilage and is good for nursery purpose.
- Germinability of freshly extracted seeds can be extended for four to six weeks by storing in moist charcoal and packed in poly bag, which favours long distance transport and in germplasm exchange programs. In few countries, the seeds are mixed with sawdust, testa is removed, peeled seeds are then treated with a fungicide either by washing in a fungicidal solution or by dusting, and packed in polythene bags. Mucilage can also be removed by soaking in lime solution.

2.5. Scientific Nursery Raising

- **Poly bags:** Black polybags of 6"x 9" size with 250 gauge thickness with drain holes is used. For raising root stocks, long poly bags may be used to hold grafted and budded plants for a longer period.
- **Potting mixture:** 2:1:1 Soil: Sand: FYM. Organic manures like coir compost, vermicompost, neem cake and compost made of cocoa leaves, pod husk and bean shell can also be used in place of Farm Yard Manure.
- **Soil solarization:** by sun drying and covering of potting mixture with black polythene sheet during March-April will enhance seedling vigour and health.
- **Polythene mulching:** in nursery floor will inhibit the weed growth in high rainfall zones. Weed mats may be used in mother gardens.
- **Biopriming:** of potting mixture with 20g '**Cocoa Probio**' formulation developed by CPCRI with *Pseudomonas putida* microbial cultures will enhance the growth and health of seedlings.
- **Trichoderma seed treatment:** will also enrich the growth and health of seedlings.
- **Green shade net:** 50-75% shade net covering with permanent pillars in an area of 2 acres will hold 50,000 bagged seedlings. Polybags are to be arranged in neat rows leaving walking path for monitoring and better management.
- **Over head misting:** cocoa is sensitive to water stress and so regular watering is required, misting is good in the initial days of germination followed by hose irrigation.
- **Drainage:** in the nursery is important during monsoon season.
- **Soil less culture:** also tried with vermicompost, coir and cocoa shell composts which showed positive impact on germination and growth of seedlings.
- **Bio-pots:** made of sun/ oven dried cocoa pod husk also can be used for upto three months to reduce poly bag usage.

- **Nursery structures:** Shade net nursery, Polyhouse with white solar sheet and Hi Tech Nursery with UV stabilised polythene covering, insect net, cooling pad, exhaust fans, overhead misting, control panel to maintain temperature and humidity for year round operation.

2.6. Sowing and Germination

- Main harvest season in the traditional zones starts in April-May months and sowing to be completed before onset of monsoon by May 15th. If delayed continuous showers will inhibit germination and invite fungal infections (Elain Apshara *et al.*, 2019).
- Sowing is to be done by keeping seeds horizontally and just covering with sand. Shallow sowing is preferable.
- Seeds start germination in about a week and will continue for another one week. **Epigeal** type germination is observed in cocoa, where cotyledons are taken above ground in the process and is called '**soldier phase**'.
- May sown seedlings will be readily available for planting during September-October, the post monsoon season in the high rainfall zones like Kerala and Karnataka.
- Compact blocks on varieties raised with clonal plants showed second season of bearing during post monsoon season, which is good for nurseries which are in operation throughout the year. It favours planting during June-July with onset of monsoon in low rainfall areas or the non-traditional zones.
- Seed and seedling standards developed by CPCRI (Elain Apshara, 2016a) and published in the Indian Minimum Seed Certification Standards Part–II in 2023 by the Central Seed Certification Board, Govt. of India. It has to be followed by all the agencies involved in seed and seedling production.

No.	Characters	Standards
1	Age of the seedling	5- 6 months
2	Height of seedling	45- 50 cm
3	Girth of seedling	3.5- 4 cm
4	No. of leaves	5- 6 pairs
5	Growth	Straight from the middle of the poly bag, without branching or jorquetting.
6	Foliage	Green, healthy, without crinkling and nutrient deficiency, middle leaves of 15 cm length and 6 cm width.
7	Root	Tap root branched with young spreading roots without netting.
8	Precautions	Free from nursery diseases and pests.
	Ball of earth in the poly bag should be wet and loose without pot bound condition. Care should be taken not to break or damage the tap root. Seedlings should not be kept in the nursery over ten months (IMSCS, 2023)	

3. Vegetative Propagation

Grafting and budding are being followed in multiplication of cocoa. Cocoa is a cross pollinated crop showing wide genetic variability. To maintain true to type of genotypes, to get early yield, to maintain optimal canopy, asexual or vegetative or clonal propagation is followed. It also ensures multiplication of identified high yielding varieties and elite clones in large quantities. Soft wood grafting method and patch budding methods are standardized in cocoa at CPCRI with 85% and 70% success respectively. For the grafting/ budding technique to be successful stock and scion compatibility is very important, which exists in cocoa.

3.1. Scion Bank or Bud Wood Garden

Apart from clonal orchards, to fix the hybrid vigour, for production of true to types and to get early yield, establishment of scion bank or bud wood gardens are important in cocoa, similar to other fruit crops like Cashew, Mango, Jack etc. with both single and multiple released varieties. Both hybrids and varieties will be multiplied as grafted or budded plants and assembled in these gardens which will produce both true to type clonal seeds as well as vegetative propagules. Around 1 acre or 200-250 mother trees are enough for this type of mother gardens/ scion banks/ budwood gardens. Recently with RKVY- Karnataka, three poly clonal orchards established at CPCRI, Regional Station, Vittal, Research Centre, Kidu and Puttur, Karnataka with 1500 trees of elite clones.

3.2. Root Stock and Scion Selection

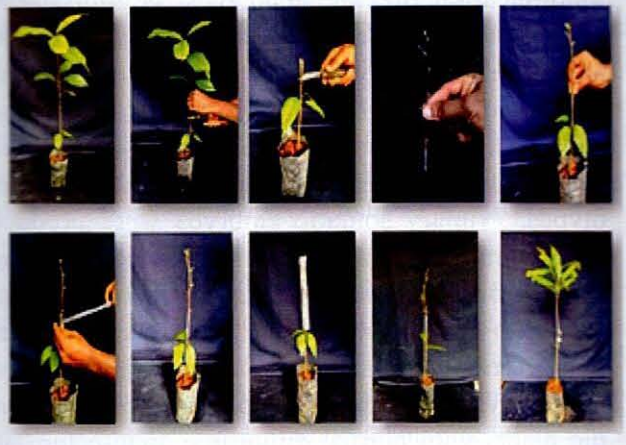
- Three to four months old seedlings raised in polybags are used as root stocks for grafting. Forastero, Trinitario types of cocoa and hybrid seedlings are being used as strong root stocks.
- For non-traditional regions, drought tolerant

root stocks are being used.

- Scion sticks of 12-15 cm length with 2-3 buds are collected from desirable high yielders.
- Root stock stem and scion stick are to be of same thickness and physiological age for successful graft union.
- Scion sticks of **chupons** (orthotropic shoots) will give seedling like architecture, whereas bud sticks of **fan branches** (plageotropic shoots) will give bushy appearance. Since the availability of fan shoots are more it is widely used in commercial nurseries and it is compulsory to practice formation and structural pruning in the second year of planting itself, to maintain optimal canopy and exploit its true potential in clonal plants.

3.3. Grafting Technique

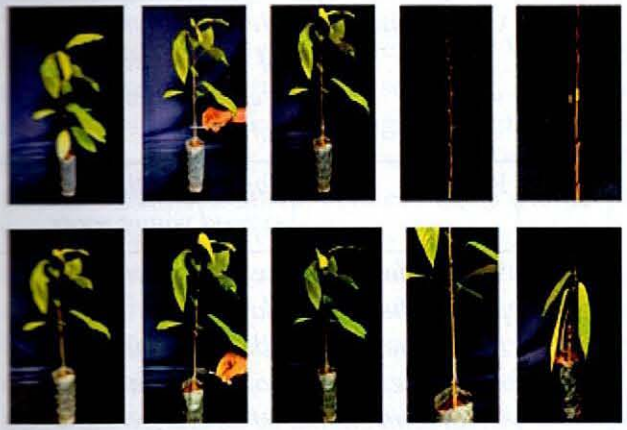
- Soft wood grafting is done by giving a horizontal cut in the upper portion of the four month old root stock with a grafting knife.
- Making a vertical slit of 2-3 cm down (cleft) on the decapitated root stock.
- Giving a 'V' shaped slanting cut of 2-3 cm length (wedge) to the defoliated scion stick.
- Insertion of the scion (soft wood) into the stock (wedge into the cleft).
- Tying tightly with a polythene strip or tape of 1.5 cm width over the joint.
- Covering with polythene pouch so that the graft joint and scion stick won't dry up and be removed after 15-20 days.
- Perfect graft joint will occur in one month, polythene strip tied over graft joint will be removed after two months or after planting in the field.
- Grafting also help in, side-grafting, top-grafting or in situ grafting in field planted seedlings and also in rejuvenation of old unproductive gardens with top-working.
- As advanced techniques, grafting tapes and clips are being used to speed up grafting.



Grafting Technique

3.4. Budding Technique

- Patch budding is done by removal of 2 cm length patch in the cotyledonary stalk of six months old root stock seedling, by gently removing the soft bark.
- From the budwood similar 2 cm length patch with active bud is removed and pasted on to the root stock and tied with polythene sheet.
- Bud take will happen in 15 days with visual sprouting of covered bud. Polythene strip may be removed after 20 days. Root stock seedling may be cut off fully or partially depend on bud take. Snapping back of root stock is practised in Kerala region for quick bud set.
- From a single bud wood, 3-5 buds can be extracted to produce 3-5 budlings than one scion stick in grafting.



Budding Technique

A skilled person can make 300 grafts per day. The emerging shoots from the rootstocks to be removed regularly. October to December season is best for grafting and all other seasons are suitable with sufficient irrigation and green house with controlled conditions. Grafting pest and disease resistant clones and conservation of multiple varieties on a single tree are the advantages of vegetative propagation methods.

Clone standards are also developed by CPCRI and published in the Indian Minimum Seed Certification Standards Part–II in 2023 by the Central Seed Certification Board, Govt.of India. It has to be followed by all the agencies involved in production of clonal propagules.

S. No.	Characters	Standards
1	Method	*Soft wood grafting*
2	Type of root stock	*Bulk Forastero, Trinitario and hybrid seedlings*
3	Root stock raising	*Poly bag seedling*
4	Size of polybag	*6" x 9" size and 250 gauge thickness*
5	Potting mixture	*2: 1: 1 Soil: Sand: FYM*
6	Age of root stock	*4- 5 months*
7	Root stock size	*Height 50 cm, 3.5 cm girth with 7 pairs of leaves*
8	Scion size	*Thickness same as root stock, soft woods of 12-15 cm length with 2- 3 buds, defoliated*
9	Graft union	*20 cm above soil, about 2 cm thickness, should be covered with polythene pouch to avoid drying*
10	Grafted plant	*Height 60 cm, 7 pairs of healthy leaves, stem straight without jorquetting*
11	Root	*Tap root with well spread young roots*
12	**Precautions:** *Remove the polythene pouch after 15-20 days. Polythene stripe tied over graft joint should be removed after 2 months. Graft joint should be above ground while planting. Emerging shoots from root stock should be nipped off. Free from nursery diseases, pests, deficiencies, pot bound condition and breakage at graft joint (IMSCS, 2023a).*	

3.5. Top Working Methods and Grafting using Clips

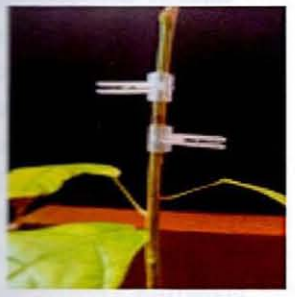
Side Grafting

Lateral Grafting

In situ Grafting

Top Working

Grafting Tape



Grafting Clip Big

Grafting Clip Small

4. *In vitro* multiplication

Cocoa shows high degree of segregation for many traits when propagated through seeds. Clonal propagation systems such as rooted cuttings and grafting have been successfully applied for the multiplication of elite genotypes. Biotechnological tools like *in vitro* multiplication of cocoa could potentially contribute to efforts at crop improvement, rapid multiplication of elite genotypes, germplasm exchange of disease free clones, *in vitro* conservation and genetic transformation. An efficient somatic embryogenesis method was reported from Pennsylvania State University in collaboration with CIRAD, France for propagating a wide variety of cocoa genotypes. Primary somatic embryos were produced from floral explants at high frequencies and large number of plants were successfully acclimated and grown to sexual maturity at St. Lucia, Brazil and West Africa. Additionally somatic embryogenesis offers a system for the clonal production of orthotropic plants with normal dimorphic architecture and tap root formation. Cocoa tissue culture research has

been focused on somatic embryogenesis, which has been developed in several laboratories since 1977. Responses of various explants such as immature zygotic embryos, cotyledon, somatic tissues like leaf, nucellus, floral explant, petals and staminods, were reported.

Anitha Karun *et al.*, 2011 listed the following strategies with biotechnological tools.

- *In vitro* multiplication/ tissue culture techniques for superior disease free genotypes through somatic embryogenesis and micro propagation.
- *In vitro* germplasm conservation, maintenance, transport, exchange and long term storage strategies.
- Embryo rescue to overcome incompatibility barriers and for production of distant hybrids.
- Anther culture for production of homozygous diploids and exploitation of hybrid vigour.
- Protoplast isolation, fusion and plant regeneration to assist in hybrid production, genetic engineering. etc.
- Developing cocoa transgenics etc.

Cryopreservation of cocoa shoot tips was carried out by three methods viz., Encapsulation-dehydration, Pregrowth-desiccation and Droplet-freezing method. For preculture, McCown's Woody Plant Medium (WPM) supplemented with sucrose 0.75M and ascorbic acid 0.1g/litre, and for retrieval, WPM medium with 0.6 M sucrose and BAP (1mg/L), GA3 (0.5mg/L) and NAA (0.2mg/L) were used. In encapsualtion–dehydration protocol, the shoot tips (2-4 mm) were encapsulated with 3% sodium alginate solution followed by cryopreservation in Liquid nitrogen (-196°C) for 24 hours. In pre growth desiccation method shoot tips were incubated in 1.5 M sucrose solution for 24 hours. In droplet freezing method shoot tips were treated with 50% DMSO solution for 2 minutes and cryopreserved in liquid nitrogen. The cell viability was tested by using 0.1% TTC (2, 3, 5 triphenyl tetrazolium chloride) solution. This preliminary studies showed the potential of pregrowth-desiccation method for cryopreservation of cocoa shoot tips (Nilosha *et al.*, 2011).

Effect of media and explants on the callogenesis of cocoa was studied with two culture media viz., DKW (Driver Kuniyuki Walnut) medium and MS (Murashige and Skoog) medium and three explants viz., leaf, cotyledons, staminode and nodal cuttings. When callus induction media developed by two labs were compared, MS basal medium supplemented with 0.5mg/l of NAA and 0.5mg/l of BAP (CPCRI, India) responded well for the callus induction than DKW basal medium (ACRI, USDA) supplemented with 2,4-D 2mg/l and TDZ 25µl (from 0.2mg/ml). Callus development was observed in staminode, leaf and cotyledon explants. Callus formation was more in leaf explants after ten days of inoculation. Irrespective of explants tried browning was more in DKW media than MS media. For optimum callus production MS basal medium supplemented with 0.5 mg/l of NAA and 0.5mg/l of BAP was found to be best for leaf explants (Bhavyashree *et al.*, 2011). Histological studies conducted revealed that the calli originated from cotyledon and staminode tissues were rich in polysaccharides and nucleic acids.

5. Advisory for diseased tracts

Seed pods free of *Phytophthora*, thrips, mealy bugs and tea mosquito bugs are only to be harvested. Pods half eaten or damaged by rats and squirrels can be discarded. Nursery shouldn't be raised in areas susceptible to vascular streak die back (VSD) (Michelle End *et al.*, 2014). Clonal materials specifically classified under high risk category for VSD. Poly green house can be utilized for screening, protection and hardening of hybrid seedlings. Preventive sprays to be taken up during monsoon season. *Trichoderma* enriched vermicompost as soil less media and Cocoa Probio found to be effective in avoiding infection by soil borne pathogens in the high rainfall zones. Asia Pacific region is free of viral diseases and so both international and national quarantine measures to be strictly followed, specifically private nurseries involving in production of exotic fruits. Seedling dieback/ blight caused by both Phytophthora and *Colletotrichum* are common in high rainfall zones for which plant protection measures are available.

6. Selection of seed centres

CPCRI nurseries are recognized by National Horticulture Board (NHB) with four star grading and accredited with Directorate of Cashewnut and Cocoa Development (DCCD), Kochi as '**Model Cocoa Nursery**'. It is advisable to procure planting materials from research institutes, recognized nurseries and regional nurseries. CPCRI supplied parental material to seventeen regional nurseries established in five states with funding from DCCD. These are in operation in Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra and Goa for unhindered supply of planting materials in the regions. Apart from that

parental clones and hybrids are in multi location evaluation in seven each of CPCRI and AICRPP centres to meet out the location specific demands with region specific best performing varieties. Growers and farmers are advised to contact these centres for their planting material needs. Progressive growers, if have promising genotypes, can inform the National cocoa research institutes like CPCRI or regional/ state Agri/ Hort. Universities/ departments for further verification, validation and certification by by the Directorate of Cashewnut and Cocoa Development (DCCD)/ National Horticulture Board.

Avilability of Mother trees at CPCRI & AICRP Centres

Centre	State	No. of trees
Central Plantation Crops Research Institute- CPCRI Centres		
ICAR- CPCRI, Kasaragod	Kerala	300
ICAR- CPCRI, Regional Station, Kayamkulam	Kerala	250
ICAR- CPCRI, Regional Station, Vittal	Karnataka	2000
ICAR- CPCRI, Research Centre, Kidu	Karnataka	2000
ICAR- CPCRI, Research Centre, Kahikuchi	Assam	200
ICAR- CPCRI, Research Centre, Mohitnagar	West Bengal	200
All India Co-ordinated Research Project on Plantation Crops- AICRPP Centres		
Coconut Research Station (CRS- TNAU), Aliyarnagar, Coimbatore.	Tamil Nadu	240
Coconut Research Station (CRS- TNAU), Veppankulam, Thanjavur	Tamil Nadu	90
Horticulture Research Station (HRS- Dr.YSRHU), Vijayarai	Andhra Pradesh	300
Horticulture Research Station (HRS- Dr.YSRHU), Ambajipeta, West Godhavari Dt.	Andhra Pradesh	90
Regional Coconut Research Station (RCRS- Dr.BSKKV), Bhatye, Ratnagiri, Dapoli	Maharashtra	150
Horticulture Research Station (HRS- AAU), Kahikuchi, Guwahati	Assam	150

Cost of planting materials at CPCRI (2025)

Seed pod- Rs.50/-, Seedling- Rs.20/-, Graft- Rs.50/-, Scion Stick- Rs.15/-, Bud Wood- Rs.30/-.

Strategies and road map for quality planting material production and supply to increase productivity

- Improved varieties evaluated in multi location trials to be planted in different regions, wherever area expansion is proposed.
- Though area expanded considerably in the recent years, the increase in production is not realized because of huge usage of seedling progenies. Plantations to be established with clonal propagules to maintain true to type, reduce perennial cropping cycle, to maintain canopy stature in mixed cropping systems and to overcome self-incompatibility problems.
- In traditional belts, existing old unproductive senile trees may be rejuvenated with top working or cleared out in phased manner and replanted with clonal material of high yielding and disease resistant varieties, specifically Kerala state which is prone to VSD.
- Region specific varieties to be planted as clones, to overcome climate change effects in non-traditional areas.
- Seed gardens/ Clonal orchards to be established in CPCRI/AICRPP centres of different regions, seed farms of State Horti. Departments, coconut farms and KVKs.
- Regional nurseries with well designed mother blocks, with basic nursery infrastructures, following seed/ seedling/ clone standards are only to be certified.
- Quarantine protocols to be followed strictly for international, national and regional transfers of planting materials after assessing the risk category of each pests and diseases and type of planting materials.
- Single source and single agency supply may be scrutinized and streamlined, specifically with the private agencies.
- Mass suppliers of seedlings from the private sectors needs to have contract farming with growers of non-traditional regions, to avoid adverse marketing issues in the Indian cocoa sector.

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