

Guidelines for preparation of Detailed Project Report for large scale production and distribution of quality planting materials including hybrids

The Coconut Development Board proposes to launch a research project in collaboration with various educational institutions having Post Graduate Degree programmes in science preferably Botany, Bio-technology etc. for production of hybrid coconut seedlings under Technology Mission on Coconut programme. The objective of the collaborative research scheme is large scale production of dwarf and hybrid seedlings (5 lakhs root wilt disease tolerant and high yielding seedlings) through hybridization techniques. In Kerala at present the average requirement of seedlings estimated is around 30 lakhs per year for new planting, gap filling and replanting.

Colleges and Post Graduate departments in Science preferably in Botany, Bio-technology etc having qualified manpower and adequate infrastructure facilities for carrying out research can forward proposals to the Board for assistance under the scheme. The project will be implemented on 50:50 basis by the Board and the concerned Departments / Institutions. Detailed proposal with costings for mother palm selection, Training on hybridization techniques and raising of nursery etc. can be supported by the Board, so that 50,000 seedlings per year can be produced by each college from the third year onwards.

Pre-requisite

A detailed project report incorporating objective, methodology, technical content, manpower, costing, project period, outcome and share of the board/ Institution should be submitted by the institution. The technical programme should include the following:

First Phase

- Survey and identification of elite palms from farmers fields.
- Screening of selected palms by different methods viz. serological techniques / ELISA test wherever required.
- Marking of mother palms.

Second Phase

- Nut collection from the identified elite palms and raising progeny rows.
- Training to pollinators on hybridisation.
- Production of hybrids through controlled pollination of selected elite palms.
- Collection of elite seed nuts and hybrid nuts.

Third Phase

- Raising coconut seedling nursery.
- Identification of hybrid seedlings.

Varieties of Coconut

The coconut palm is a monocot belonging to the genus 'cocos'. It is a monotypic genus having only one species -'nucifera'. Under *Cocos nucifera* there are two varieties known as the tall and the dwarf. Influenced by the geographical location and the prevailing climatic conditions, a number of cultivars have evolved within the tall and the dwarf varieties. Besides the tall and the dwarf varieties various combinations of hybrids have been developed by crossing the tall and the dwarfs. They are known as TxD (tall x dwarf) or DxT (dwarf x tall) according to the variety chosen as the female parent in the cross.

Tall Cultivars

The tall cultivars are taller in stature growing to a height of 20-25 m. Their life span extends from 80 to 90 years or more. They normally are cross pollinated and come to bearing in about 5 to 7 years after planting and attain steady bearing in about 12 to 15 years after flowering. The nuts of the Tall cultivars are generally medium to big size with good quality and quantity of copra and fairly high oil content (60-72%) as compared to those of the Dwarf cultivars. The tall cultivars are generally used for commercial planting. Some of the tall cultivars grown in India are: West Coast Tall, East Coast Tall, Tiptur Tall, Benaullim Tall, Andaman Tall, Andaman Giant, Kalpadhenu, Kalpaprathibha, Kalpamithra, Chandrakalpa, Kerachandra, Kalpatharu, Lakshadweep Ordinary and Lakshadweep Micro

Dwarf Cultivars

The Dwarf cultivars are generally self pollinated, short statured and bears early. The palms commence bearing in about 3-4 years after planting. They are short-lived with a life span of about 40-50 years. The nuts are smaller, the copra soft, leathery and oil content low (60-66%) with little demand in the market. The dwarf cultivars exhibit three different nut colours viz. green, yellow, and orange. They are grown for ornamental purposes, tender nut use and as parents in the production of TxD and DxT hybrids. Some of the dwarf cultivars grown in India are: Chowghat Dwarf Orange, Chowghat Dwarf Green, Malayan Dwarf (orange, yellow and green), Gangabondam, Kalparaksha and Kalpasree.

Hybrid Cultivars

Hybrids are produced by controlled pollination using Tall and Dwarf varieties as parents. In TxD hybrid, the tall variety is the female parent and the dwarf variety, the male parent. In DxT hybrid, the dwarf variety is the female parent and the tall variety, the male parent. The hybrid seedlings on planting has rapid growth rate with a higher rate of leaf production. It has shorter pre-bearing period and high bearing capacity. They start bearing from the 4th year of planting, have high annual yield of about 95-116 nuts per tree and produce good quality copra. The oil content of nut is about 65-69%.

Though both Tx D and DxT are heavy yielders, research data and field experience indicate that the DxT is better for regularity in bearing. With adoption of proper scientific management practices, including assured irrigation DxT & TxD can be cultivated successfully. Under average management and unirrigated conditions the local tall varieties are more suitable.

Hybrid Varieties

a) Tall x Dwarf (T x D)

1. Kerasankara (WCT x COD)
2. VHC-1 (ECT x MGD)
3. VHC-2 (ECTx MYD)
4. Lakshaganga (Laccadive Ordinary x Gangabondam)
5. Keraganga (WCT x Gangabondam)
6. Anandaganga (Andaman Ordinary x Gangabondam)
7. Kerasree (WCT x MYD)
8. Chandralaksha(LO x COD)

b) Dwarf x Tall (D x T)

1. Chandrasankara (COD x WCT)
2. Kalpasamrudhi (MYD X WCT)
3. Kalpasankara (CGD X WCT)

Hybrid/Cultivers viz Kalpasankara, Kalparaksha and Kalpasree have been recommended for rootwilt disease tracts.

PERFORMANCE OF HIGHYIELDING COCONUT CULTIVARS VARIETIES AND HYBRIDS

Cultivar/Variety and Hybrids	Average Yield nuts/palm/year	Copra Content g/nut	Oil Content %	Oil Yield t/ha
1. WCT	81	176.0	68.0	1.69
2. ECT	86	100.0	63.0	0.96
3. Andaman Ordinary	94	160.2	66.0	1.73
4. Laccadive Ordinary	98	176.0	70.0	2.11
5. Banawali Green Round	151	151.6	68.4	2.74
6. Kappadam	90	283.5	67.0	2.99
Dwarf Variety				
7. Gangabondam	60	148	68.0	
8. COD	91	99	66.0	
9. CGD	66	92	66.0	
10. MOD	91	130		
11. MYD	66	130	66.0	
Exotic				
13. Fiji Tall	106	199.1	65.2	2.41
14. Fiji Longtongan	104	210.5	66.0	2.53
15. Philippines Ordinary	108	196.1	66.0	2.45
16. Philippines Laguna	88	258.9	66.5	2.65
17. S.S. Green	108	186.1	67.0	2.36
18. Sanramon	64	349.6	68.0	2.66
Hybrids				
19. Chandrasankara (COD x WCT)	99.8	208.4	68.0	2.47
20. Chandralaksha (LO x COD)	99.3	195.5	68.0	2.31
21. Lakshaganga (LO x GB)	108.3	194.5	73.1	2.74
22. Keraganga (WCT x GB)	100.2	201.0	69.0	2.48
23. Anandaganga (AO x GB)	95.2	216.0	68.0	2.47
24. VHC-1 (ECT x MDG)	100.0	135.0	68.6	1.59
25. VHC-2 (ECT x MYD)	108.0	152.0	70.0	2.01
26. ECT x Gangabondam	140.0	150.0	68.0	1.69
27. Kerasankara	106.0	198.0	38.0	-
28. Kalpasamridhi	117.0	220.0	67.5	-
29. Kalpasankara	84.0	170.0	67.5	-

Technical content

Planting material

Productivity of any crop depends on the quality of planting material. Quality planting material is the key to success in the cultivation of any crop especially in the case of perennial crops like coconut where yield can be realized only after a long period. The seedling vigour is highly correlated with adult palm characters such as early flowering, nut yield and copra production. In a perennial crop like the coconut palm which exhibits considerable genetic variations and is capable to being propagated only through seed, the selection and use of planting material of high intrinsic value assumes considerable importance. The palm contributes to yield for over 80 years and the full bearing capacity becomes known only 10 to 15 years after planting. If the planting material happens to be unselected and inferior in quality, the garden will prove to be highly uneconomical and a continuous source of loss to the grower. Since coconut culture involves substantial pre-bearing investment, greater emphasis must be given to the selection and use of the right type of planting material. By means of a series of selection made at different stages, it is possible to eliminate poor quality seed nuts and seedlings. Based on the research results guidelines for selection of seeds were developed which includes the selection of garden, selection of mother palms and collection of seeds.

Selection of Seed Gardens

Seed gardens should have a record of consistently high yield and the garden should contain a high proportion of heavy bearers. It should be free from incidence of disease and pests. It is not advisable to select mother palms from very small holdings maintained under very favourable conditions. Palms growing under very favourable conditions and receiving special care should be avoided as it will be difficult to assess their inherent yielding ability. Palms located near cattle sheds and compost pits should preferably be avoided.

Selection of Mother Palms

The mother palms selected for collecting the seed nuts have to be identified on the basis of its features viz. yield, copra content, size and shape of the nut nature of the crown and age of the palm. The mother palms are to be selected with great care on the basis of several characters as below.

- The mother palms should be regular bearers and should give annual yield of not less than 80 nuts.
- The shape of crown should be spherical or semi-spherical
- Petiole length and stalk of the bunches should be short and strong in nature
- Bearing habit should be regular with at least 80 nuts annual yield during the last 5 years.
- Palms which have reached full bearing stage and giving regularly high yield for at least four consecutive years should be selected and very old palms above 60 years should be avoided.
- A high yielding mother palm in its middle age will have at any time 30 to 40 fully opened leaves on its crown.
- The petioles should be short and stout and be able to give effective support to the coconut bunches.
- The bunch stalks should also be short and strong and should not have the tendency of droop down.
- Trees having medium sized nuts with nearly round or spherical shapes are better for selecting as mother palm.
- The nuts should have a weight of more than 600 g and the copra weight should be above 150g.
- Palms producing barren nuts, alternate / bearing irregular should be avoided.

Selection of Dwarf Varieties

The following points are to be borne in mind when dwarf palms are selected for breeding purpose either as male or female parent.

1. Dwarf palms comes to flowering earlier than tall by at least 2-3 years.
2. Even surface planted dwarfs do not show bole (stem base thickened with emerging roots all around).
3. Leaf-scars on the stem will be very closely arranged.
4. The girth of the stem will be less when compared with tall.
5. The leaves will be shorter, petiole length less and leaflets closely arranged on the leaf.
6. The width of the leaflet will be considerably narrower than that of tall.

7. Self pollination is generally seen in dwarf unlike in tall, since in dwarf the female flowers come to receptive stage even when the male flowers have not shed from the same inflorescence.
8. Retention of the female flowers are seen along with normal nuts in the same bunches.
9. High female flower production is also a character of the dwarfs.
10. Generally three distinct colours are available for the dwarf viz orange, green and yellow.

Serological detection of healthy elite mother palms / ELISA Test

Root (wilt) disease free nature of elite palms selected in hot spots are confirmed by serological test by continuous monitoring and repeated serological tests, disease free palms are selected as source palms and are used for producing quality seedlings either from open pollinated seed nuts or by appropriate hybridization techniques. The serodiagnostic test can also be used for detecting disease free seedling in the nursery before the appearance of any visual symptoms. Serodiagnostic tests viz., Immuno diffusion test (Agar gel double diffusion test) and ELISA (Enzyme Linked Immuno Sorbent Assay) have been standardized for early detection of root (wilt) disease. These tests are very reliable and easy to perform. ELISA is a highly sensitive test and 95% sensitivity is observed with root (wilt) samples. Using the serological tests, diseased nature of the palms could be detected 6-24 months before the appearance of visual symptoms. At present, Immunodiffusion test and ELISA are the widely used serological tests for the selection of root (wilt) disease-free palms. The presence / absence of phytoplasma in these palms are confirmed by these tests. For collection of leaf samples, creamy white tender leaflets (2 nos.) from the middle portion of the spindle are used for the test. As far as possible the samples should be sent immediately after collection to the serology laboratory. For this, leaf samples collected should be labeled and properly packed in polythene bags. If the laboratory is situated away from sampling site the leaves packed in polythene covers should be stored in ice boxes / buckets and sent to the laboratory at the earliest.

Technique for production of hybrids in coconut

The coconut inflorescence is called 'spadix', and of 1-2 m long, consisting a central axis or rachis, with lateral branches called rachillae. Each rachillae bearing 200-300 male flowers from the top down and some have one or more female flowers at their base. The female flowers known as buttons develop into nuts, whereas male flowers shed after dehiscence of anthers. The male flowers opens first in an inflorescence, beginning at the top of each spikelet and proceeding towards the base. In tall palms, the female phase usually

begins 22 days after the spathe has opened and lasts for 4-6 days whereas the male phase extends for 16-22 days. There is a gap of 2-3 days between male and female phases in these varieties. However, in dwarf varieties, the male and female phases overlap, resulting in self-pollination. Coconut is essentially entomophilous and agents like honeybees facilitate natural pollination, apart from pollination by wind. Artificial pollination occurs when the natural process of pollination is replaced by artificial methods.

Selection of parental palms

The selection of the parental palms has a major role in the production of quality planting materials by hybridization. Proper care should be taken for selection of the parental palms both male and female for artificial pollination. The parental palms selected should be free from pests and diseases and also of high yielding producing approximately 80-100 nuts per palm per year.

Equipments required

- Pollination Bag: It is essential to protect the receptive female flowers from pollinating agents. Cotton cloth bags, measuring approximately 75 cm x 50 cm, having a transparent plastic window (to view the receptive stage of female flowers) are used as pollination bag.
- Dessicator: Pollen is usually stored in a dessicator with fused calcium chloride as desiccant. The pollen collected in small vials, is plugged with non absorbent cotton and kept in dessicator. They can be stored for 10-12 days without appreciable loss of viability.
- Applicator for spraying pollen grains: Pollen applicator consists of a plastic squeeze bottle with a rubber tube at its mouth. Another rubber tube with a rubber bulb at one end is connected to the plastic bottle just below the neck. When the rubber bulb is pressed, it pumps air into the squeeze bottle and the pollen-chalk mixture inside the bottle is released as a cloud, into the pollination bag.

Collection of pollens

The male flowers collected from the male parental palms are processed for pollen collection. The male flowers on the middle portion of the spikelets produce more fertile pollen compared to those on the upper and lower portion of the spikelet. Male flowers should be collected from the male parental palms before opening of individual male flowers which is usually done 2-4 days after the opening of inflorescence. Maturity of the male flower is indicated by the bluish green tinge at the tip. These mature male flowers are

placed in between two sheets of newspaper and slightly crushed using a wooden rolling pin to separate the perianth parts. The crushed male flowers are dried in an incubator maintained at 40°C for a period of 24 hours. In case if incubator is not available, it can also be shade dried for 1-2 days. On completion of drying, the pollen is collected by sieving the dried male flowers using a sieve with mesh size of 0.2 mm. Pollen is preserved in dessicator to maintain its viability.

Emasculation and Bagging

Emasculation is the process of removal of male flowers from the female parental palm. Emasculation is usually done by cutting the spikelets 5 cm above the female flowers using a secature / knife. The male flowers seen in between or near the female flowers should be removed by hand. Dwarf parental palms have to be emasculated within 3-5 days of opening of the inflorescence. Bagging is done to prevent pollination in emasculated inflorescence by natural means and is done a few days before the female flowers become receptive. Bagging is done 3-4 days before the initiation of female phase in an inflorescence.

Method of artificial pollination

The pollen grains is usually mixed with a suitable diluent like purified talc in 1:9 ratio and filled in the applicator. Twenty gram of pollen is sufficient for pollinating 45 to 50 bunches. Pistillate flowers become receptive during early morning hours which shows a reflexed moist stigmatic surface and the nectar is secreted at the base of the stigma and pericarp. A small hole has to be made on the plastic sheet and the tube of the pollen applicator is inserted through this hole. The rubber bulb attached with the applicator should be pressed afterwards to spray the pollen-chalk mixture inside the pollination bag. This pollen application process should be carefully done to ensure that the pollen-chalk mixture cloud covers the receptive female flowers. All the female flowers do not attain receptivity on the same day, so the above process should be repeated till all the female flowers in an inflorescence become receptive. After spraying the pollen-chalk mixture, the hole is closed using an adhesive tape. The pollen from the same parent should be used for individual inflorescence. The most ideal time for carrying out artificial pollination is during the morning hours, 7 am to 11 am since maximum stigmatic exudation occurs during that time.

On completion of the fertilization process the stigma turns brown and the secretion of nectar stops. After 3-5 days, when all the buttons in an inflorescence attain this stage, the pollination bag should be removed and the bunch should be labeled. Mature nuts can be harvested 11 months after pollination in dwarf palms and 12 months after pollination from tall parental palms.

Collection of seed nuts

The next step is collection of seed nut. The time of seed nut collection may vary from region to region according to the seasonal conditions. Always it is better to collect nuts that had undergone development during rainy season for seed nut purpose. The shape and size should be proper, any type of damage of the nut during harvesting is to be avoided. The nuts are to be lowered by ropes only to get an undamaged embryo, the presence of water is to be judged by shaking the nuts and getting clear metallic sound on tapping. Fully matured nuts will have dry husks with a distinct browning of the inner fibres. Gurgling sound of water within the nut can be heard on shaking them.

Preservation of seed nuts

Storing of nuts is another important step towards quality seedling production. The seed nuts after harvest are not immediately planted in the nursery. Usually the seed nuts are stored in shade for about a month till the husk becomes dry to facilitate speedy and maximum germination. Then they are arranged on the floor of a shed over 7-8 cm thick layer of dry sand with their stalk end up and covered with the sand to prevent drying of nut water. Five layers of nuts can be arranged one over the other. During summer sprinkling of water is needed to prevent the drying of nut water. Storage has no bad effect on the viability of seed nuts or the quality of the seedlings.

Nursery Techniques

Proper practice of raising seedlings in the nursery for subsequent planting is essential, because selection of seedlings is facilitated in the nursery. Also irrigation and the initial upkeep of the seedlings are easier and more economical in a nursery.

Selection and preparation of seed beds

The nursery is best raised in the open with adequate shade provided in summer. It can also be raised in gardens where the trees are tall and the ground is not completely shaded. Too much shade makes the seedlings grow lean and lanky. Well drained coarse-textured sandy soils should be preferred for raising a nursery. The nursery must be located near a dependable water source to facilitate satisfactory irrigation. Raised beds may be prepared in places and where drainage may be a problem during heavy rains. If the soil is not sandy, it may be necessary to treat the soil with insecticide to prevent the attack from white ant and root grub. The soil may be treated with BHC 10% dust @ 60 kg/ha or Chlordane 5% dust @ 120 kg/ha as a precaution against white grubs and termites.

The nursery beds should preferably be long and narrow with a spacing of 30 cm between nuts and 40 cm between rows and provision of space for walking and drains-in-been. The width may be adjusted so that a bed contains 4 or -5 rows of seedlings with a 80 cm spacing between beds. This will enable examination of the seedlings and work of the nursery from the sides without getting into the beds.

Sowing seednuts

The proper time for sowing nuts in the nursery will vary from fruit to fruit depending upon the monsoon. By planting at the commencement of the rainy season it will be possible to avoid heavy and frequent watering required for good germination. May-June is the most appropriate time for planting seed nuts in the nursery in the west coast region.

The seednuts may be sown in trenches 20 cm deep and 40 cm apart in the nursery beds either vertically or horizontally with a spacing of 30 cms between the nuts (centre to centre). Though a higher percentage of germination is obtained with the horizontal planting, no difference is manifest in the performance of the seedlings as compared to vertical planting. Vertically planted seedlings are easier to handle when seedlings are to be transported over a long distance and can be packed compactly. In the horizontal planting, nuts may be sown with the widest of three segments at the bottom and in vertical planting the stalk-end up. The depth of planting may be adjusted so that the husk is just visible at the surface.

Raising seedlings in polybags

In order to avoid the transplanting shock of the seedlings, it is possible to raise the seedlings in polybags. For this initially the nuts are sown vertically in the nursery closely and when they start germinating out in 8 to 10 weeks at every fifteen days the sprouted nuts are collected and placed in a black polybag of 500 gauge measuring 60cm x 45 cm, filled with potting mixture. The sprouts are thus collected for a period of 5 months from the date of sowing. These polybags are kept at a distance of 0.75 to 1.00 m from bag to bag.

Nursery Management

Management of the nursery involves the creation of optimum condition for the early and maximum germination of seed nuts and subsequent healthy growth of seedlings optimum conditions are provided by attending to regular irrigation, weeding, mulching and control of pest and diseases. In the absence of rains, the nursery has to be watered twice a week or more often according to necessity. It is also to be kept free of weeds by periodical weeding.

During dry and hot weather, the nursery beds should be mulched and shaded with dry coconut leaves or any other suitable material. Coconut leaf mulch has been reported to promote early and better germination, good growth of seedlings and to give high percentage of good seedlings. A careful watch must be kept for the incidence of pests and diseases so that proper control measures can be taken promptly and in time.

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Selection of hybrid seedlings

Hybrid coconut seedlings are identified in the nursery stage based on characters like early germination, petiole colour and seedling vigour. However, petiole colour is the most widely used marker to select hybrid seedlings in the nursery stage. D X T hybrid seedlings can be selected based on the exclusive characteristics of the male parent viz., colour of petiole, length and breadth of leaves and leaflets, etc. One year old seedlings usually show hybrid vigour for collar girth, number of leaves, length and breadth of leaves and leaflets, etc. Colour of petiole is one of the most commonly used distinguishing characteristics and hybrids are usually selected based on the colour of petiole and collar girth

Removal of seedlings from nursery

After selection, the seedlings should be removed from the nursery only just before they are required for transplanting in the field. These seedlings should not be pulled out by force, but their roots should be neatly cut and the seedlings with the nuts gently removed. Pruning of roots is not harmful in younger seedlings (7 to 12 months old) but may cause some delay in establishment and retard the growth of older ones. The seedlings pulled out of the nursery should be planted as early as possible, preferably before 10 days.

Cultivation of hybrids will significantly increase the coconut productivity in India and will also enhance the income of coconut farmers. Hence, large scale production of released hybrids of coconut should be given top priority by the institutes engaged in this.

Estimated costing for hybrid seedling production programme		
	Components	Amount (Rs)
	Non Recurring	
1	Land for nursery (lease value for 3 years)	100000
2	a) Laboratory Building	400000
	b) Equipments for pollen bank	217000
3	Documentation	10000
	Recurring	
4	Manpower	
	a) Project Assistants (2 nos)	720000
5	Cost for mother palm lease (2000 x 750 x 2)	3000000
6	Cost for hybridisation/ pollinators	480000
7	Training on hybridisation	50000
8	Expenses for raising nursery/ labour	270000
9	Travel/ transport	30000
	ESTIMATED TOTAL COST	5277000

ESTIMATED REVENUE		
	Components	Amount (Rs)
1	First year	
	Sale of dwarf seednuts	1920000
2	Second year	
	Sale of dwarf seednuts	720000
3	Third year	
	Sale of hybrid seedlings	4800000
	Sale of dwarf / NCD seedlings	700000
	TOTAL	8140000
4	Fourth year onwards	5500000 per year

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