

Coconut Varietal Improvement - A Reflection of 50 Years of Research

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Indian research on coconut genetics and varietal improvement is one of the oldest in the world dating back to 1916. Collections from all the coconut growing countries were introduced in India in 1924 while it was only in 1952 intensive germplasm collection and exchange started. These collections were planted in Nileshwar and Kasaragod which formed the basic materials for coconut improvement. The intensive efforts were taken by the Indian Central Coconut Committee set up in 1945 which initiated research activities from 1947. It was fifty years ago the Kayangulam research station was also set up for controlling the root (wilt) disease. Hence the major research activities on coconut started about fifty years ago. From 1947 onwards many research institutes/stations were established for research on coconut. In Kerala, Kumarakom Coconut research Station and Coconut Research Station, Balarampuram were established in early fifties. Regional Coconut Research Sta-

tions were established at Veppankulam in Tamil Nadu, at Arisikere in Karnataka, at Ambajipet in Andhra Pradesh (East Godhavari Dist.) and at Ratnagiri in Maharashtra in the fifties. Besides these research stations other research stations were also started at West Bengal (Mondouri) and Orissa (Konarak). These research stations cater to the needs of the different agroclimatic regions. The Indian Council of Agricultural Research (ICAR) took over the Central Coconut Research Station at Kasaragod from

Indian Central Coconut Committee subsequent to its dissolution in 1966 later the All India Coordinated Coconut and Arecanut Improvement Project was also started at Kasaragod. Seventies saw intense research on Coconut by CPCRI and ten Co-ordinating Centres. These research institutes alongwith CPCRI have released 11 hybrids out of the total 33 released through out the world. Besides, India has the world's largest collection of coconut germplasm.

Improvement of Specific Traits in Coconut

The crop improvement in coconut through selection and hybridization has been one of the major objectives of coconut research workers for the last 65 years. The genetic improvement in coconut is a difficult and time consuming process because of the long gestation period, requirement of large area for experimental planting, resources required for experimentation, low seed multiplication rate and lack of a reproducible clonal propagation technique. With all these limitations, India was the first country in the world to exploit hybrid vigour in coconut in a cross between West Coast Tall x Chowghat Green Dwarf (Patel 1937). This discovery was a significant land mark in the history of coconut improvement and paved the way for the success-



Fig. 1. Chandrakalpa

ful exploitation of this phenomenon in many of the coconut growing countries. John and Narayana (1943) found that these hybrids (Tall x Dwarf) gave higher yields, combining the nut and copra characters of tall with early bearing of the dwarf parent. The evaluation of the 25 year old TxD(WCT x CGD) planted at Nileswar has revealed that they were early bearing, high yielding and attained steady bearing earlier than the tall parent with higher number of functional leaves (Bhaskaran and Leela, 1964).

Breeding for Drought Tolerance

Coconut is being grown in different types of soil under different agroclimatic conditions. It is estimated that an average monthly rainfall of 50 mm is necessary for ideal growth and nut yield of the palm. Any erratic distribution and low average rainfall will adversely affect the yield of the palm. The four Southern States, Andhra Pradesh, Tamil Nadu, Karnataka and Kerala where 90 percent of the coconut is being cultivated, are facing drought condition frequently. It has been realised that the only way towards increasing coconut production in drought affected area is the evaluation of drought tolerant varieties and hybrids.

Studies conducted at CPCRI, to identify desirable traits of drought tolerant cultivars based on the accumulation of epicuticular wax on the leaf surface, low stomatal frequency and leaf water potential, the activity of certain enzymes like glutamate oxaloacetate

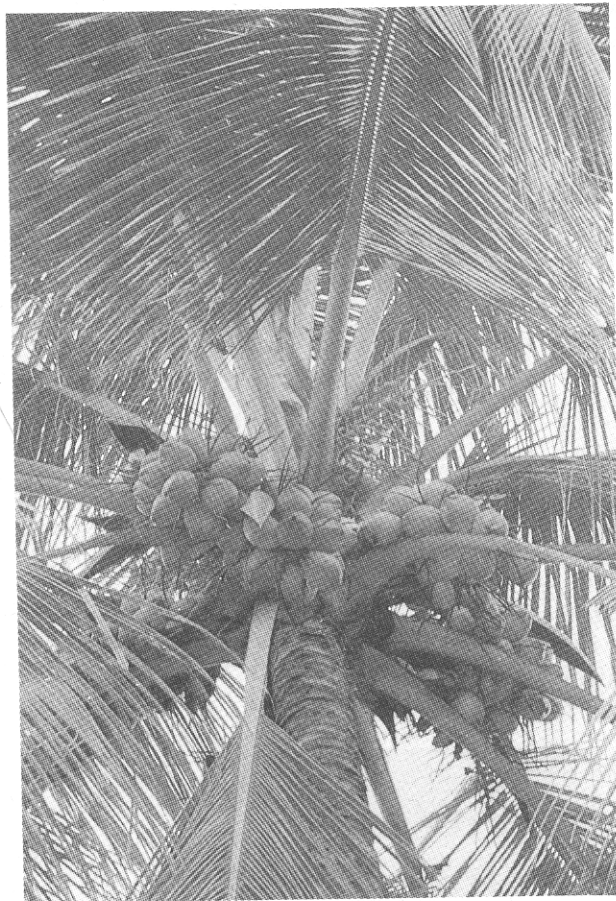


Fig. 2. Pratap

transaminase (GOT) and acid phosphatase indicated that out of 23 cultivars and hybrids screened for the drought tolerance, WCT x WCT, Federated Malay States (FMS), Java Giant, Andaman Giant and LO x COD are drought

tolerant (Rajagopal *et. al.* 1988 a). Recent studies conducted by Rajagopal *et. al.* (1988 b) have proved the superiority of the hybrids LO x COD and LO x GB for drought tolerance. The reduction in yield during drought affected years for LO x COD and LO x GB was 15 percent and 44 percent respectively compared to 75 percent in drought affected COD x WCT hybrids. All the identified drought tolerant varieties are currently being utilized in the breeding programme at CPCRI, Kasaragod.

Breeding for disease Resistance

The root (wilt) disease of coconut is the most serious problem causing an annual loss of 968 million nuts in eight districts of Kerala (Anon 1985). The characteristic symptom of this disease is flaccid-

ity, yellowing and necrosis of leaflets (Menon and Pandalai, 1958) followed by a progressive decline in the yield. Systematic studies carried out at CPCRI have conclusively shown the presence of mycoplasma like organisms (MLOs)

Table - 1: Coconut Germplasm Assemblage at CPCRI Kasargod

Region	Number of Accessions			
	Talls	Dwars	Semitalls	Hybrids
Indigenous				
India	34	12	-	-
Exotic				
Asia & South - East Asia	20	6	1	-
Africa	4	2	-	1
Central and South America	6	1	-	-
Pacific Ocean Is.	40	4	1	-
Total	104	25	2	1

in the sieve tube of roots, tender stem, inflorescence and petiole of diseased palms (Solomon *et. al.*, 1983).

The screening of the available coconut germplasm and hybrids has not yielded any resistant type. Therefore, survey in the hotspot area, for the identification of disease free palms was undertaken and 162 high yielding apparently healthy WCT palms and 19 CGD palms were initially selected and subjected to serological and physiological tests. Based on these tests 26 WCT and 19 CGD palms were selected and crossed. The first batch of 32 progenies of WCT selfed and 48 progenies of CGD x WCT have been planted in the field. The seedlings of the same combination are evaluated in insect proof cages and *Stephanitis*

typica, which is proved as a vector transmitting the disease, fed on root wilt affected palms were released to transfer the disease to seedlings. The control seedlings have developed the disease whereas the CGD x WCT seedlings are disease free. The same combination planted in the open field at CPCRI, Research Station, Kayangulam also have not shown any disease symptom indicating their tolerance/resistance to the disease. They are being monitored.

The other serious diseases of coconut are bud rot caused by *Phytophthora palmivora*, stem bleeding disease and Thanjavur wilt/ *Ganoderma* disease. As these can be controlled by conventional plant protection measures, at present no breeding work is being done to develop

Table-2: Comparative performance of cultivars at CPCRI, Kasargod

Cultivar	Nuts/Palm/Year			Copra		
	Bearing age (Years)	Number	Percent age increase over WCT	Per nut (g)	Per Palm per year (kg)	Percentage increase over WCT
Exotic Type						
Fiji Tall	6	106	32.5	199	21.1	52.9
Philippines Ordinary	5	110	37.5	198	21.8	57.9
SS Green	6	108	35.0	186	20.0	44.9
Indigenous Type						
Lakshadweep Ordinary (Chandrakalpa)	6	100	25.0	176	17.6	27.5
Andaman Ordinary	6	94	17.5	169	16.0	15.9
Benaulim (Pratap)	7	150	87.5	152	22.8	65.2
West Coast Tall	7	80	-	172	13.8	-

a resistant genotype for this disease. However all the germplasm collection of coconut are being

evaluated to identify a suitable resistant type for the future breeding programme.

Selection of Suitable Tendernut Variety

Seven months old tendernut of coconut is becoming increasingly popular as a natural, refreshing drink especially during the summer months. A study was initiated at CPCRI, Kasaragod to find out suitable cultivar for tendernut purpose. A total of 46 cultivars were screened based on the organoleptic studies for nut water quality and further 12 varieties out of them were subjected to biochemical evaluation. The studies indicated that Chowghat Orange Dwarf (COD) had the maximum amount of total sugars (70.g/10 ml), reducing sugars (4.7 g/100 ml) and optimum sodium and potassium content (Dhamodaran *et. al.*, 1991).

Varietal Development

The earliest exotic introductions were made in 1924 from the Philippines,

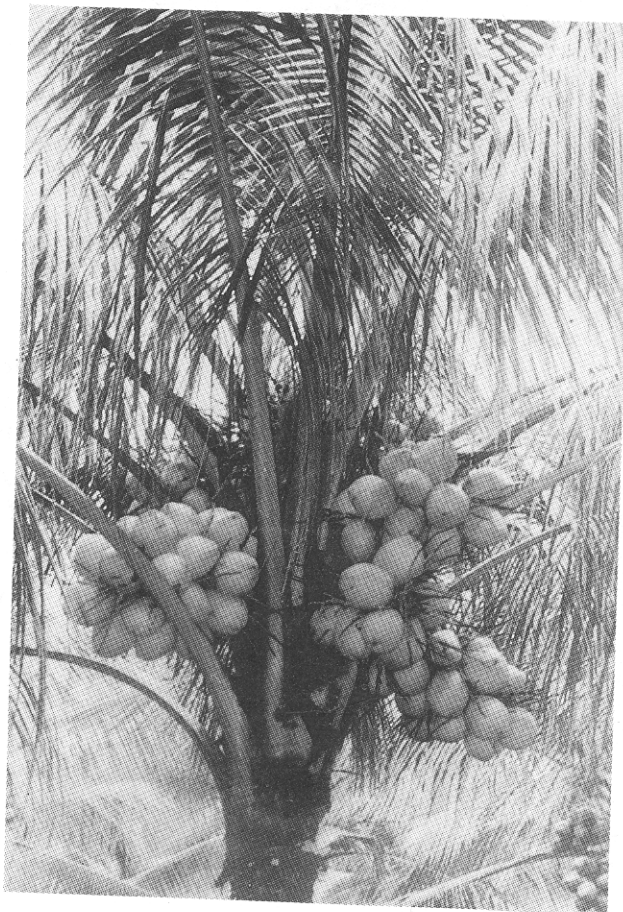


Fig. 3. Chowghat Orange Dwarf (COD)

Malaysia, Fiji, Indonesia, Sri Lanka and Vietnam. The germplasm exchange programme was intensified in 1950. The collection of indigenous coconut germplasm gained importance in 1958 and some of the indigenous types were added to the germplasm repository during this period as well as exotic collections from Pacific and Indian Ocean Islands.

The present coconut germplasm repository at CPCRI, Kasaragod, has 86 exotic and 46 indigenous types (Table-1). The exotic collections from 22 countries comprise 70 tall, 13 dwarf, one semi-tall and one hybrid. The indigenous collection comprises 34 tall and 12 dwarfs including 11 accessions collected from Andaman & Nicobar and Lakshadweep Islands. With the financial assistance from IBPGR (now IPGRI), 24 accessions (20 tall and 4 dwarfs) were collected from six Pacific Ocean Countries viz., Solomon Islands, Fiji Islands, Tonga Islands, American Samoa, French Polynesia and Papua New Guinea and the same have been maintained at the World Coconut Germplasm Centre (WCGC), Andamans.

Recently 15 accessions from three Indian Ocean Islands viz., Mauritius (6 accessions), Madagascar (4 accessions) and Seychelles (5 accessions) have been collected in the form of zygotic embryos.

Coconut Cultivars

In coconut, there are only two varieties namely, the tall and the dwarf. The tall variety is cultivated for its copra, oil and fibre, while the dwarf cultivars are planted for ornamental purpose and also for the sweet tendernut water. Now they are extensively cultivated for the production of Dwarf x Tall and Tall x Dwarf hybrids. The tall palms are highly

Table - 3: Performance of released hybrids

Hybrids	Nut yield palm/year	Copra yield		Copra yield/ha (t)	Oil content (%)	State for which recommended
		Mean /nut (g)	Mean /palm (kg)			
Chandra Sankara (CODxWCT)	116	215	25	4.4	68	Kerala Karnataka Tamilnadu
Kera Sankara (WCTxCOD)	108	187	21	3.5	68	Kerala Karnataka
Chandra Laksh (LOxCOD)	109	195	21	3.7	69	Kerala Karnataka
Laksha Ganga(LOxGB)	108	195	21	3.7	70	Kerala
Ananda Ganga(AOxGB)	95	216	21	3.6	68	Kerala
Kera Ganga(WCTxGB)	100	201	21	3.5	69	Kerala
Kera Sree (WCTxMYD)	112	216	24	4.2	66	Kerala
Kera Sowbagya (WCTxSS Apricot)	130	195	25	4.3	65	Kerala
VHC-1 (ECTxDG)	98	135	13	2.3	70	Tamilnadu
VHC-2 (ECTxMYD)	107	152	16	2.9	69	Tamilnadu
Godhavari Ganga (ECTxGB)	140	150	21	3.7	68	Andhra Pradesh
WCT (Control)	80	176	14	2.5	68	

cross pollinated in nature and hence the progenies obtained from the palms of this type may not perform like the mother parent from which they are produced. However, the dwarf are comparatively homogeneous with varying degrees of self fertilization.

Comparative Performance of Cultivars

Among the exotic accessions, Fiji Tall, Philippines Ordinary and SS Green have been found to give highest copra yield of 20 kg/palm per year (Table 2). Among the indigenous types, Lakshadweep ordinary, Andaman Ordinary and Benaulim are superior to the local West Coast Tall.

Four varieties have been so far recommended for release, namely, Chandra Kalpa, Pratap, Chowghat Orange Dwarf and Chandra Tara. Based on the overall performance of promising cultivars at

various Research Centres in Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Kerala, the cultivar Lakshadweep Ordinary was released during 1985 for commercial cultivation under Chandra Kalpa (Fig. 1). This cultivar yields 25 percent more nuts and 27.5% more copra than local tall under Kasaragod condition. Another cultivar, Banawali Green Round from Ratnagiri (Maharashtra) was selected and released in 1987 by Konkan Krishi Vidya Peeth, Dapoli, for cultivation in Konkan Coast 'Pratap' (Fig. 2).

Based on the organoleptic test of tendernut water in 46 cultivars, 12 cultivars were selected for a detailed biochemical analysis like total sugars, reducing sugars, amino acids, sodium and potassium contents (Damodharan *et al.* 1991). In view of the superior

quality of tendernut water, Chowghat Orange Dwarf (Fig.3) was recommended for release in 1991. The quantity of tendernut water in this cultivar ranges from 300 to 400 ml/nut. The mean total sugar is 7.1 g/100ml with 2000 ppm of potassium and 20 ppm of sodium contents. The exotic cultivar Philippines Ordinary (Fig.4) was tested under three different agroclimatic regions and found superior with respect to the nut yield as well as copra yield over the local cultivar. The mean yield of nuts/palm/year in this cultivar is 110 with copra yield of 20.8 kg/palm/year, thereby showing an increase of 37.5 percent and 50.7 percent respectively over West Coast Tall. Moreover, the increase with respect to nut yield as well as copra yield over the released variety 'Chandrakalpa' was 12.2 and 20.9 per cent respectively. This cultivar was recommended for release as a 'National variety' (Chandra Tara) during the XII Workshop of All India Coordinated Research Project on Palms (AICRPP), held during December 1995 for commercial cultivation. It was released for Andhra Pradesh as Double Century.

Exploitation of Hybrid Vigour

Ever since the report of heterosis in Tall X Dwarf hybrids by Patel (1973), various hybrids involving tall and dwarfs have been evaluated for their increased productivity. In the immediate years following the discovery of hybrid vigour in coconut, the emphasis was on the production of Tall x Dwarf hybrids. These hybrids were pre-



Fig. 4. Philippines Ordinary



Fig. 5. Chandrasankara (CODxWCT)

cious and high yielding compared to local cultivar, West Coast Tall, under irrigation and good management.

Till the middle of 1950s, the emphasis was on the production of T x D hybrids. More than 90 combinations using different Talls and Dwarfs like Chowghat Orange Dwarf (COD), Gangabondam (GB) and Chowghat Green Dwarf were evaluated over the years at CPCRI and various centres under the All India Coordinated Research Project on Palms. In view of the high yield performance, the hybrids, COD X WCT (Fig.5), LOxCOD (Fig.6) and WCT x COD (Fig.7) were recommended for release in various years starting from 1985 under the name Chandra Sankara, Chandra Laksha and Kera Sankara, respectively. Subsequently, the Kerala Agricultural University (KAU) and Tamil Nadu Agricultural University (TNAU) also evaluated and released 7 more hybrids viz. Laksha Ganga (LO x GB), Ananda Ganga (AO x GB), Kera Ganga (WCT x GB), Kera Sree (WCT x MYD), Kera Sowbhagya (WCT x SS Apricot) from KAU and VHC-I (ECT x DG) and VHC-2 (ECT x MYD) from TNAU. Recently the Andhra Pradesh Agricultural University has released a hybrid namely, Godhavari Ganga (ECT x GB). The comparative performance of these hybrids indicate that in terms of nut production and copra yield, they are superior to local tall compared to the 80 nuts per palm of WCT, and the yield varies from 95 to 140 nuts per palm per year (Table 3).

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Fig. 6. Chandralaksha (LO x COD)

..... Buko in syrup?

Buko in syrup is young tender coconut meat soaked in syrup and used or served either as a dessert, pie filling, ingredient in fruit salad, ice-cream, sherbets and other food preparations.

As food, buko in syrup is considered as a nutritious dessert or snack item. The eating quality of buko in syrup actually approximates that of fresh young tender coconut meat (*buko*) both in terms of texture and taste. It contains 9.17% soluble solids, 3.76% reducing sugar, 15.39% total sugar and it has a pH of 6.16.

The process of preparing buko in syrup starts with the selection of freshly harvested and crack-free 7-8 months old young and tender coconuts. The selected nuts are washed thoroughly with water and then cut into halves. With the use of a scraper made from carabao horn or spatula, the tender meat is scooped out from the shell. There are about 8 to 10 scoops per halved nut. While scraping the tender meat, care should be taken not to scrape off the testa or the brown portion between the white meat and the shell.

After scraping, the meat is immediately dipped in the previously prepared dipping solution to prevent discoloration. The dipping solution is prepared by dissolving sodium metabisulfite in water or buko water at the rate of 1% solution.

The coconut meat is then cut into strips or any desired size and shape. The cut meat is drained and washed thoroughly with water to remove the sulfite. Then the meat is packed in previously sterilized glass jars or tin cans and the container is inverted to drain any excess liquid.

The syrup is prepared by dissolving one part sugar for every two parts of water. Vitamin E is added to the syrup then heated to boiling. The hot syrup is poured into the packed meat leaving 1/4 inch headspace.

The containers are partially sealed and processed at 15 psi for 30 minutes in a pressure cooker or sterilizer. The containers are then tightly sealed and cooled in inverted position. Upon cooling, each container (glass jar or tin can) is labelled and stored in a cool dry place.

Buko in syrup is an export product; it could be done as a cottage industry (village level) or as a medium-scale industry. As a value-adding enterprise, the processing of buko in syrup will undoubtedly benefit the coconut producers, processors and exporters.

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