Genetic resource management and improved varieties of coconut

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Introduction

The coconut palm, *Cocos nucifera L.*, is a multi-purpose palm grown widely in the humid tropics and in India it is referred to as 'Kalpavrisksha' considering that it provides all necessities of life. Coconut provides nutritious food and refreshing drink, oil for edible and non-edible uses, fibre of commercial value, shell for fuel and industrial uses, timber and a variety of miscellaneous products for use as domestic fuel. About 10 million families depend on coconut for their livelihood and as an important oil crop in the country, it contributes about 7.8 per cent to the national vegetable oil pool. In recent years, coconut is being increasingly considered as a health food, with virgin coconut oil, tender coconut water and inflorescence sap (neera) being promoted for consumption.

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The average national productivity of coconut in India is around 64 nuts per palm per year. Certain elite coconut palms are reported to yield more than 400 coconuts per palm per year. With a focus to improve productivity and overall profitability to the farmers, research efforts have been focused on development of high yielding coconut varieties.

Coconut palms are broadly classified into the talls and the dwarfs. Tall palms are the most commonly cultivated in all coconut growing regions of the world. Dwarf palms are not grown on a commercial scale. They are of shorter stature, 8-10 m high when 20 years old and start bearing about 3-4 years after planting

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Diversity in coconut forms

The coconut palm, *Cocos nucifera L.,* a monotypic species under the genus Cocos, exhibits a lot of variability in forms with several distinct populations and ecotypes, widely differing from each other in morphological characters, particularly with respect to fruit characters and plant habit.

Plant habit

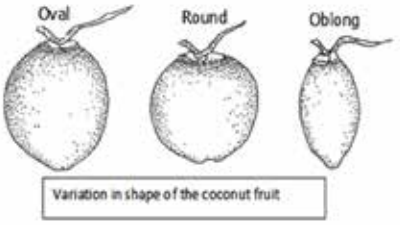
Coconut palms are broadly classified into two groups based on plant habit viz., the talls and the dwarfs. Tall palms, also referred to as var. typica, and are the most commonly cultivated in all coconut growing regions of the world. Tall palms grow to a height of 20-30 m, have a sturdy stem, commence flowering 6-10 years after planting and continue bearing up to the age of 80-100 years. Tall palms are normally cross-pollinated and hence highly heterozygous. The fruits are generally medium to large in size and produce good quantity and quality of copra with fairly high oil content. Among the indigenous tall cultivars, West Coast Tall (WCT), East Coast Tall (ECT), Benaulim Tall (BENT), Tiptur Tall (TPT), Andaman Ordinary Tall (ADOT) and Laccadive Ordinary Tall (LCT) are popular. Some popular exotic tall cultivars are Fiji Tall (FJT), Philippines Ordinary Tall (PHOT), Sri Lankan Tall (SLT), West African Tall (WAT), Panama Tall (PNT), Malayan Tall (MLT), Jamaican Tall (JAMT) and San Ramon Tall (SNRT).

Dwarf palms are referred to as var. nana. They are not grown on a commercial scale. They are of shorter stature, 8-10 m high when 20 years old and start bearing about 3-4 years after planting and have a short productive life of about 40-50 years. The dwarf palms are more homozygous than talls, due to a high degree of self-pollination. They produce fruits, which are generally small to medium in size. The dwarfs are presumed to have originated from talls either through mutation or by inbreeding. The popular dwarf cultivars grown in India are Chowghat Green Dwarf (CGD), Chowghat Orange Dwarf (COD), Kenthali Orange Dwarf (KTOD) and Gangabondam Green Dwarf (GBGD). Among the exotic dwarf cultivars, Malayan Yellow Dwarf (MYD), Malayan Orange Dwarf (MOD) and Malayan Green Dwarf (MGD) have become popular in all coconut-growing countries of the world.

The tall and dwarf types have been utilized for development of hybrid varieties, combining the early flowering trait of dwarfs with the hardiness and high yielding character of tall parents and also exploitation of hybrid vigour.

Fruit characters

Considerable diversity is observed in the size, shape and colour of fruits of coconut palm. The colour of the fruit varies from yellow, shades of green and brown to red (orange). The variations in shapes of the coconut fruit are broadly classified as round, oblong or elliptic. Further, based on the equatorial view, the shape of coconut fruits can be classified as angled, round or flat based on the curvature of the fruit and the presence of ridges on the fruit. Variations are recorded in shape of the nut inside the fruit and these are broadly categorized as round, oval and oblong.



Variation in shape of the coconut fruit

Coconut genetic resources

CPCRI, being the premier national institute undertaking coconut research, maintains the world's largest repository of coconut germplasm and is designated by the National Bureau of Plant Genetic Resources (NBPGR) as the National Active Germplasm

Site for coconut in the country. Over the years, CPCRI has collected, for conservation and characterization, about 455 coconut accessions, including 132 exotic and 323 indigenous collections. In addition, CPCRI also hosts the International Coconut Gene Bank for South Asia at CPCRI Research Centre Kidu in Karnataka under a tripartite agreement among ICAR-FAO-ITPGRFA, besides the National Coconut Gene Bank (NCGB).

The large collection of coconut germplasm maintained at CPCRI is being characterized and evaluated for agronomic characters, yield and performance at the institute. Promising accessions are then evaluated for their performance and regional adaptability at the 15 centers under the All India Coordinated Project on Palms, located in nine State Agricultural Universities, one Central Agricultural University and two research institutes.

Crop improvement research, through evaluation and utilization of coconut genetic resources in the country, has resulted in the development of several improved varieties, through mass selection and hybridization approaches and the improved varieties and hybrids are capable of producing 1.63 to 6.2 tonnes of copra/ha/year. So far, 20 coconut hybrid varieties and 29 selections have been developed and released for commercial cultivation in different agroclimatic zones and states of the country. Breeding efforts in the country in addition to development of high yielding varieties suitable for copra/oil/tender nut have also focused on development of disease resistance, especially to root (wilt) disease, moisture stress tolerance and varieties for ornamental purpose.

Varieties evolved through selection

Selection and evaluation of promising accessions conserved both at the institute, the coordinating centers under the All India Coordinated Research Project on Palms and State Agricultural Universities have resulted in the development and release of 29 high yielding varieties of coconut, suitable for different agro climatic zones, through application of mass selection. Table 1 indicates the varieties suitable for cultivation in the different states of the country.

Exploitation of hybrid vigour

In India, heterosis breeding has been employed for development of hybrid coconut varieties through hybridization between indigenous and exotic

selections of Talls and Dwarfs. The first coconut hybrid in the country was produced at the erstwhile Coconut Research Station, in 1934 by Dr. J.S. Patel using West Coast Tall as female parent and Chowghat Green Dwarf as male parent. The resultant hybrid progeny exhibited seedling vigour in the nursery, resulting in the first documented report in the world of hybrid vigour/heterosis in coconut by Patel in the year 1937. Subsequently, these hybrids manifested earliness in flowering, increased nut yield, higher copra yield with better quality of copra and oil compared to the parents. In the immediate years after the discovery of hybrid vigour in WCT x CGD hybrids, the emphasis was on development and evaluation of Tall x Dwarf (T x D) hybrids. Subsequently, Dwarf x Tall (D x T) hybrids were also produced and evaluated, considering the occurrence in the nursery of naturally crossed dwarfs (NCD) in open pollinated progenies of dwarf palms. Much later, Tall x Tall (T x T) and Dwarf x Dwarf (D x D) inter-varietal hybrids were also produced at the Institute for evaluation of the hybrid progenies for yield and other desirable traits. Till date, more than 100 cross combinations have been developed for evaluation of yield potential at CPCRI, SAUs and the centres under the AICRP on Palms. So far, 20 hybrids, including seven superior Dwarf x Tall hybrid varieties and 13 Tall x Dwarf hybrid varieties have been developed for commercial cultivation in different parts of the country (Table 2). These hybrids are capable of producing 2.79 to 6.2 tonnes of copra/ha/year.

Breeding for drought tolerance

Drought is one of the major limiting factors that considerably reduce nut production. However, severity of drought and response of palms to

Table 1. Improved coconut varieties developed through selection				
Variety	**Important traits**	**Nut yield (ha-1 year-1)**	**Copra yield (t ha-1 year-1)**	**Recommended states/regions**
Tall				
Chandra Kalpa	Drought tolerant, high copra, oil content	17700	3.12	Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra
Kera Chandra	High yield, dual purpose variety for copra and tender nut	19470	3.86	Kerala, Karnataka, Konkan region, Andhra Pradesh, West Bengal
Kalpa Pratibha	High nut, oil yield, dual purpose variety for copra and tender nut	16107	4.12	Kerala, Andhra Pradesh, Tamil Nadu, Maharashtra
Kalpa Mitra	High nut, oil yield, drought tolerant	15222	3.68	Kerala, West Bengal
Kalpa Dhenu	High nut, oil yield, drought tolerant	14160	3.41	Kerala, Tamil Nadu, Andaman & Nicobar Islands
Kalparaksha	Semi-tall, high nut and oil yield in RWD prevalent areas; tender nut purpose	13260 (17748)#	2.85 (3.34)	Kerala, Root (wilt) disease prevalent tracts
Kalpa Haritha	Dual purpose variety for copra and tender nut; less eriophyid mite damage	20886	3.70	Kerala, Karnataka
Kalpatharu	Drought tolerant, ball copra, high yield	20709	3.64	Kerala, Karnataka, Tamil Nadu
Pratap	High yield	26727	4.01	Maharashtra
Kamarupa	High yield	17877	2.90	Assam
ALR (CN) 1	High yield	22302	3.50	Tamil Nadu
Kera Bastar	High yield	19470	3.18	Chhattisgarh, Maharashtra, Tamil Nadu, Andhra Pradesh
Kalyani Coconut	High yield	14160	3.84	West Bengal
Kera Keralam	High yield	26019	3.53	Tamil Nadu, Karnataka, Kerala
ALR (CN) 2	High yield	21240	2.89	Tamil Nadu
VPM-3	High yield, drought tolerant	14868	3.41	Tamil Nadu
Kera Sagara	High yield	17523	3.64	Kerala
Kera Madhura	Semi-tall, dual purpose variety for copra and tender nut	24480	4.80	Kerala
Double century	High yield	23140	4.60	Andhra Pradesh
Kalpa Shatabdi	Tall, dual purpose variety for copra and tender nut	18375	5.01	Kerala, Karnataka, Tamil Nadu
Dwarf				
Chowghat Orange Dwarf	Tender nut purpose, orange colour fruit	22848	3.20	All coconut growing regions for tender nut
Gouthami Ganga	Tender nut purpose, green colour fruit	13260	2.08	Andhra Pradesh
Kalpasree	Early flowering, green colour fruit superior oil, recommended for root (wilt) diseased areas	18360	1.77	Root (wilt) disease prevalent tracts
Kalpa Jyothi	Tender nut purpose, yellow colour fruit	23256	3.30	Kerala, Karnataka, Assam
Kalpa Surya	Tender nut purpose, orange colour fruit	25092	4.69	Kerala, Karnataka, Tamil Nadu
CARI-C1 (Annapurna)	High copra content, tender nut purpose, green colour fruit	10526	2.53	Andaman & Nicobar Islands
CARI-C2 (Surya)	Ornamental purpose, orange colour fruit	23317	1.63	Andaman & Nicobar Islands
CARI-C3 (Omkar)	Ornamental purpose, yellow colour fruit	27744	2.04	Andaman & Nicobar Islands
CARI-C4 (Chandan)	Ornamental purpose, orange colour fruit	18870	1.92	Andaman & Nicobar Islands
#- Figures in parenthesis indicate yield in root (wilt) disease free tracts				

Table 2. Coconut hybrids released for commercial cultivation in India

Hybrid Variety	Source population of parents	Important traits	Nut yield (ha-1 year-1)	Copra yield (t ha-1 year-1)	Area recommended
Chandra Sankara	COD x WCT	High yield	20532	4.27	Kerala, Karnataka, Tamil Nadu
Kera Sankara	WCT x COD	High yield, drought tolerant	19116	3.78	Kerala, Karnataka, Maharashtra, Andhra Pradesh
Chandra Laksha	LCT x COD	High yield, drought tolerant	19293	3.76	Kerala, Karnataka
Kalpa Samrudhi	MYD x WCT	Dual purpose variety, Drought tolerant, higher nutrient use efficiency	20744	4.35	Kerala, Assam
Kalpa Sankara	CGD x WCT	Tolerant to root (wilt) disease, high yield	14868	3.20	Root (wilt) disease prevalent tracts
Laksha Ganga	LCT x GBGD	High yield	19116	3.73	Kerala
Ananda Ganga	ADOT x GBGD	High yield	16815	3.63	Kerala
Kera Ganga	WCT x GBGD	High yield	17700	3.56	Kerala
Kera Sree	WCT x MYD	High yield	23364	5.05	Kerala
Kera Sowbhagya	WCT x SSAT	High yield	23010	4.49	Kerala
VHC-1	ECT x MGD	High yield	21240	2.87	Tamil Nadu
VHC-2	ECT x MYD	High yield	25134	3.74	Tamil Nadu
VHC-3	ECT x MOD	High yield	27612	4.47	Tamil Nadu
Godavari Ganga	ECT x GBGD	High yield	18585	2.79	Andhra Pradesh
Konkan Bhatye coconut hybrid 1	GBGD x ECT	High yield	20532	3.47	Maharashtra
Kalpa Ganga	GBGD x FJT	High yield, suitable for ball copra production	21417	3.38	Karnataka
Vasista Ganga	GBGD x PHOT	High yield	22125	3.88	Andhra Pradesh, Karnataka
VPM-5	LCT x CCNT	High yield	28497	4.22	Tamil Nadu
Kalpa Sreshta	MYD x TPT	High yield, Dual purpose for copra and tender nut	29227	6.28	Kerala, Karnataka

drought are location specific. Therefore, once physiological traits are identified, selection of most appropriate cultivars for a given environment is possible. Laccadive Ordinary was found to be relatively more tolerant to drought than other cultivars. The hybrids LCT x COD and LCT x GBGD were also found to give higher yields under drought conditions.

CPCRI has identified certain drought tolerant cultivars like Federated Malay States, Java Giant, Fiji and Andaman Giant. All these identified drought tolerant cultivars are being used in the breeding programme at CPCRI, Kasaragod to identify high yielding hybrids possessing drought tolerance.

Breeding for disease resistance

Coconut root (wilt) disease is the most serious problem causing an annual loss of 968 million nuts in the eight southern districts of Kerala and now spreading to the neighboring districts of Kerala and Tamil Nadu. As no effective control measures are available for this disease, developing resistant/tolerant genotypes and the identification of sources of resistance is of utmost importance. Recent findings revealed that cultivars CGD and MGD showed higher level of resistance than other cultivars. Hence, a survey for the identification of disease–free palms in 'hot spot' areas (heavily diseased tracts) has been undertaken and 'disease free palms' were selected based on the serological and physiological tests. Also, some disease free CGD and COD palms were identified in 'hot spot' areas. These palms are being utilized

in the breeding programme for the production of tolerant/resistant hybrids. Among the different combinations identified, CGD x WCT was found to be tolerant to root (wilt) disease and steps have been taken to produce these hybrids on a large scale for planting in disease endemic areas, to screen them for field tolerance to root (wilt) disease, in the 'hot spot' districts of Alappuzha, Kollam, Pathanamthitta and Kottayam. Nucleus seed gardens have been established with the progenies of these identified tolerant / resistant palms for meeting the future planting material needs and crop improvement for root (wilt) resistance.

Description of coconut varieties released from ICAR- CPCRI

The practical identification of varieties is very important for the growers, extension functionaries, and nursery men as well as for the research workers. To familiarize the stakeholders with the coconut varieties developed at the Institute, a brief account of the characteristic features of the varieties developed by the Institute and recommended for commercial cultivation are described below.

Among the 14 selections released by CPCRI for commercial cultivation, Chowghat Orange Dwarf, Kalpa Surya and Kalpa Jyothi are released as exclusive tender nut varieties. Kalparaksha and Kalpasree are recommended for root (wilt) affected tracts, as disease tolerant varieties. Kalpa Pratibha, Kera Chandra, Kalpa Haritha, Kalparaksha and Kalpa Shatabdi are recommended as a dual purpose varieties suited for both copra and tender nut purpose. Kalpatharu is recommended as a ball copra variety, owing to minimal spoilage and higher recovery percentage of ball copra. The varieties, Chandra Kalpa, Kalpa Mitra, Kalpa Dhenu and Kalpatharu are also relatively tolerant to drought.

Dwarf varieties

Chowghat Orange Dwarf

Chowghat Orange Dwarf is recommended as a tender nut variety for cultivation in the country. It is a selection from the indigenous orange dwarf IND 007 found sparsely cultivated throughout the west coast region of India, particularly in the Chavakkad area of Thrissur district of Kerala. The palm has a thin stem with closely arranged leaf scars, a small compact crown with characteristic orange colour on leaf petioles, inflorescences and fruits. This is an early flowering cultivar and takes about 3-4 years for initial flowering. This is largely a self-pollinating cultivar. The palms of this variety are sensitive to moisture stress and also show alternate bearing habit. Under irrigated and well maintained gardens, higher average annual yield of 112 nuts/palm can be realized.

The fruits are small with an average weight of 634 gm and average copra content of 128 gm/nut and 66 % oil. The variety Chowghat Orange Dwarf was found to have the highest total sugar content in the tender nut water on comparative evaluation of tender nut water quality in 44 accessions at CPCRI, Kasargod and hence was developed by CPCRI as a tender nut variety. The tender nut water of 7 month old fruit is sweet with a total sugar content of 7.0 gm/100 ml and sodium and potassium contents of 20 ppm and 2000 ppm, respectively and organoleptically graded as 'very good'. The variety Chowghat Orange Dwarf was recommended by the X Biennial Workshop of the All India Coordinated Research Project on Palms in 1991 as a tender nut variety for cultivation in the country.

Further, this variety also serves as parental palm for production of Kera Sankara (WCT x COD) and Chandra Sankara (COD x WCT) hybrid varieties of coconut. Hence, COD has been planted in isolated blocks in the seed gardens in Kerala, Karnataka and Tamil Nadu for the production of seed nuts of Dwarf x Tall (Chandra Sankara) as well as Tall x Dwarf (Kera Sankara) hybrid varieties. This variety also has potential in landscaping as an ornamental coconut palm.

Kalpasree

Kalpasree variety of coconut, is developed by the Central Plantation Crops Research Institute, Regional Station, Kayamkulam, as a superior, root (wilt) disease resistant variety with high yield potential for cultivation in homesteads in root (wilt) prevalent tracts, by selection from the indigenous dwarf cultivar, Chowghat Green Dwarf. The variety is early flowering and takes about 2.5 to 3 years for flowering. The leaf petioles, leaves and nuts are dark green in colour. The fruits are oblong in shape and have a characteristic 'beak' when fully mature. Kalpasree has superior quality of coconut oil, very sweet tender nut water and meat and is resistant to root (wilt) disease. The palm attains a height of around 4 m at 20 years of age. It can be grown for tender nut purpose as it contains nut water of 240 ml and is very sweet in taste. The nutritive value of tender nut water is as follows: total sugars-4.80 g/ml, potassium content -2150 ppm, sodium content

- 22.40 ppm. The data on fatty acid profile of the coconut oil from this variety, reveals that Kalpasree is rich is long chain unsaturated fatty acids (LUSFA's) and is healthier compared to oil of WCT and COD. Coconut oil of Kalpasree also has 25% to 40% more essential fatty acids during all seasons compared to oil from WCT and COD, respectively. Besides, Kalpasree oil is rich in essential fatty acids especially linoleic acid. However, the variety is more sensitive to biotic stress and caution is advised to adopt plant protection measures against major pests particularly red palm weevil, when large scale commercial plantings are adopted.

The recommendation is based on the superior performance of Kalpasree at CPCRI, Regional Station, Kayamkulam and in various farmers plots located in 'hotspots' of root (wilt) disease. The variety was recommended for release by XIX Biennial Workshop of the All India Coordinated Research Project on Palms in the year 2009 and released and notified for cultivation in the root (wilt) affected tracts of the country by the Central Sub-committee on Crop Standards, Notification and Release vide Notification of Ministry of Agriculture (Department of Agriculture and Co-operation) S.O. 456(E) dated March 16, 2012.

Kalpa Jyothi

Kalpa Jyothi variety is derived from the CPCRI accession IND 058, an introduction from Malaysia, acquired in 1961. The population was developed at CPCRI through selection of superior high yielding palms and inter se mating between the selected palms. This variety was evaluated and found to perform well with high yielding dwarf variety at CPCRI, Kasaragod and CPCRI Research Centre Kidu and also at the AICRP on Palm centres in Karnataka and Assam. Kalpa Jyothi variety gives higher yield of 114 nuts per palm per year over the local control (COD) in terms of annual nut yield as well as copra yield/palm. The estimated nut and copra yield per hectare was 114% and 123% higher than COD under rainfed conditions at Kasaragod. The variety is recommended for cultivation in the coconut growing tracts of Kerala, Karnataka, Assam states as a dwarf variety. The recommendation is based on the superior performance of the variety at CPCRI, Kasargod in Coastal Kerala, CPCRI, Research Centre, Kidu and AICRP On Palms centres at HRS, Arsikere in Karnataka and HRS, Kahikuchi in Assam.

The palms of this variety are relatively dwarf in habit with a compact spherical canopy. The fruits are medium, round in shape and yellow in colour. The quantity of tender nut water is around 380 ml and good in taste with TSS of 5.9. The nutritive value of tender nut water: total sugars – 6.2 g/100ml, free amino acids -1.7 mg/100ml, sodium – 36 ppm, potassium – 1998 ppm. The average fruit weight of Kalpa Jyothi variety is 649 g, with copra content of 142.42 g/nut, with copra oil content of 61.5%. The palms are regular bearers and commence flowering 38 months after planting in the field. However, the average time taken for flowering in 50% of the palms in the population is 51 months. No major disease outbreaks were observed under field conditions. However, the palms of this variety are moderately susceptible to bud rot. No major pest attacks observed under field conditions. However, the palms of this variety are attacked by rhinoceros beetle as well as red palm weevil. It is also moderately affected by eripohyid mite. Dwarf varieties in general are classified as drought susceptible and recommended for large scale cultivation only under irrigated conditions. However, among the dwarfs evaluated, this variety exhibits better tolerance to water stress conditions.

The variety Kalpa Jyothi has distinguishing characteristics of yellow petiole colour, yellow fruit colour, thin fruit shell thickness, low fruit weight, and very low shell weight. Kalpa Jyothi is stable for most

of the grouping traits. However, about 5% variability is expected due to inherent heterozygosity of the crop and hence seedling selection is to be followed.

Considering the superiority of this dwarf variety for nut yield, coupled with tender nut water quality, the XXI Biennial Workshop of the All India Coordinated Research Project on Palms during the year 2012 recommended that this variety may be released as a dwarf tender nut variety for commercial cultivation.

This variety is a high yielding dwarf variety and will contribute to enhancing coconut productivity in the country. It has the potential to yield 29947 nuts per ha of coconut garden and this can be harnessed to tap the tender nut water requirement. Further, the yellow colour of the fruits is also aesthetically very attractive and hence this variety can also be used for avenue planting with adequate precaution to prevent falling of dry fruits/leaves on pedestrians.

Kalpa Surya

Kalpa Surya variety is essentially derived from the CPCRI accession IND 048 Malayan Orange Dwarf originally introduced from Malaysia in 1959 (EC 548007). This population was developed at CPCRI through selection of superior high yielding palms and inter se mating between the selected palms in the population. This variety gives higher yield of 123 nuts per palm per year under irrigated conditions, with 71.18% higher annual nut yield over the local control (COD). In addition to CPCRI, Kasaragod in Coastal Kerala, Kalpa Surya variety was evaluated and found to be a high yielding dwarf variety at AICRP on Palms - Coconut Research Station, Aliyarnagar, Tamil Nadu and Arsikere, Karnataka.

The palms of this variety are dwarf in habit with a compact spherical canopy. The fruits are medium, oval in shape and orange in colour. Under irrigated conditions, the palm attains a height of 6.5 metres at the age of 26 years. Under irrigated conditions, initiation of flowering is observed within three years of planting. However, under rainfed conditions, average time taken for flowering in 50% of the palms in the population is 59 months. The seed nuts of this variety germinate quickly with 50% of the nuts germinating within 66 days after sowing. Germination during storage is also observed in this variety.

Based on the oraganoleptic test; the tender nut water is classified as “very good” in taste. The quantity of tender nut water is around 400 ml with TSS of 6.2. The nutritive value of tender nut water: total sugars – 6.7g/100ml, free amino acids -1.8mg/100ml, sodium – 35 ppm, potassium – 2142 ppm.

Dwarf varieties in general are classified as drought susceptible and recommended for large scale cultivation only under irrigated conditions. This variety is sensitive to drought stress and is on par with the COD variety for this trait. No major pest attacks observed under field conditions. However, palms of this variety are attacked by rhinoceros beetle as well as red palm weevil. It is also moderately affected by eripohyid mite. No major disease outbreaks have been observed under field conditions. However, the palms of this variety are moderately susceptible to bud rot and fruit rot.

The variety Kalpa Surya has distinguishing characteristics of medium fruit husk thickness, long husked fruits, medium husk weight and low shell weight. The variety is recommended for cultivation in the coconut growing tracts of Kerala, Karnataka and Tamil Nadu states as a dwarf tender nut variety in the XXI Biennial Workshop of the All India Coordinated Research Project on Palms during the year 2012. The recommendation is based on the superior performance of the variety at CPCRI, Kasaragod, AICRP on Palms - Coconut Research Station, Aliyarnagar, Tamil Nadu and Arsikere, Karnataka, dwarf plant habit as well as the tender nut water parameters.

The variety Kalpa Surya has the potential to produce about 32083 nuts per year per ha coconut garden, under irrigated and good management and

this can be harnessed to tap the tender nut water requirements.

Tall /Semi Tall varieties

Kalparaksha

Kalparaksha is semi tall variety with higher level of resistance to root (wilt) disease and with sweet tender nut water, developed by Central Plantation Crops Research Institute, Regional Station, Kayamkulam. Kalparaksha was developed as a selection from Malayan Green Dwarf population introduced from Malaysia. Kalparaksha showed 22.4% root (wilt) disease incidence in comparison to 84.0% disease incidence in West Coast Tall (WCT) coconut, fifteen years after planting. The diseased palms of this variety scored an average disease index of 15.5 in comparison to a disease index of 45 in WCT. Kalparaksha attains a height of around 4.14 meters at 12 years of age and comes to flowering by 55 months from planting. Kalparaksha gives an average nut yield of 88 nuts/palm/year with copra content of 185 g/nut, and oil content of 65.5%. With estimated oil yield of 1.87 tons/ha, this variety out yields the popular cultivar WCT in the root (wilt) disease tracts of Kerala and is superior to WCT in all important yield attributes. No major pest attack is observed in this variety in field conditions. However, under large-scale plantings precaution is advised against red palm weevil incidence. Kalparaksha, under disease-free and rain fed condition at the Central Plantation Crops Research Institute, Kasaragod gives an average annual per palm yield of 86.8 nuts/palm with yield of 16.38 kg copra/palm and 10.65 kg oil/palm.

Tender nut water content of Kalparaksha is 290 ml and the tender nut water is sweet to taste and organoleptically graded as 'very good'. The nutritive value of tender nut water of Kalparaksha is as follows: Total sugars - 4.92 g/ml, Potassium content - 2100 ppm, Sodium content - 19.50 ppm. Hence, this variety is also recommended for large scale cultivation as a tender nut variety.

The variety is recommended for cultivation in the state of Kerala by XVIII Biennial Workshop of the All India Coordinated Research Project on Palms.

Chandra Kalpa

The variety Chandra Kalpa was developed by CPCRI, Kasaragod during the year 1985. It is a selection from IND008 Lakshadweep Ordinary (LCT), an indigenous coconut cultivar from Lakshadweep Islands. It resembles WCT in growth habit and fruit characters. However, the fruits of this variety

are comparatively smaller and angular with three prominent ridges seen on the mature fruits. The fruit colour varies from greenish yellow to yellow-green. The average annual yield is 100 nuts/palm and the estimated copra yield of 17 kg/palm/year/year. The variety produces 25% more nuts and 27.5% more copra than the local West Coast Tall at CPCRI Kasaragod.

Fruits are medium sized with an average fruit weight of 800 g, copra content of 176 g/nut and copra oil content of 72%. This variety is suited for production of ball copra. About 6000 to 7000 nuts are required to make one tonne of copra. The oil of this cultivar contains comparatively high concentration of medium chain fatty acids and is preferred for edible purposes. It is also preferred for pharmaceutical industries, as the oil contains high saturated fatty acid with high lauric acid concentration (48.9 %). The tender nut water content is around 285 ml and organaoleptically graded as "good" in taste. The tender nut water has total sugar content of 4.2 g/100ml, sodium content of 50 ppm and potassium content of 2762 ppm. The palms of this variety are also good for tapping 'neera' (inflorescence sap), which can be consumed as such or converted to palm sugar/jaggery.

The palm grows in all types of soil and can withstand moisture stress. This variety was recommended by the VII Biennial Workshop of the All India Coordinated Research Project on Palms, in the year 1985, for large scale cultivation

in the states of Kerala, Karnataka, Andhra Pradesh, Tamil Nadu and Maharashtra, based on the performance of this variety at CPCRI, Kasaragod, CPCRI Research centre Kidu and the AICRP on Palms centres.

Kera Chandra

Kera Chandra was developed as a selection from IND014, the exotic accession Philippines Ordinary Tall. The palms of this variety grow to a height of 10-12 m, are regular bearers and produce large, round and green fruits. It is a good yielder with an annual average yield of 110 nuts/palm and copra yield of 20.8 kg/palm/year/year, an increase of 37.5% and 50.7% for nut and copra yield over the local West Coast Tall.

The seed nuts of this variety germinate early, with majority of the nuts germinating within two months after sowing in the nursery.The fruits are large, with mean copra content of 198 g/nut and 66% oil content in copra. Because of the high concentration of saturated fatty acids and high saponification value, the oil of this variety is more suitable for the soap industry.

The variety Kerachandra also has good quantity and quality of tender nut water. The tender nut water content is around 450 ml and organaoleptically graded as "very good" in taste. The tender nut water has total sugar content of 5.86 g/100ml, sodium content of 24 ppm and potassium content of 2273 ppm. The variety is not suitable for ball copra production, since >75% of the nuts get spoiled due to germination during the process of ball copra production.

The variety Kerachandra has distinguishable characteristics of green petiole, with high collar girth, presence of split leaves in seedlings, broad leaflets, many spikelets per inflorescence, very high quantity of tender nut water, green coloured fruits, round fruit shape over polar and equatorial views, broad fruits, round husked fruits and high shell weight. The variety shows superior performance at CPCRI Kasaragod in coastal Kerala and also in the AICRP on Palms centres in Maharashtra, West Bengal, Andhra Pradesh. Because of its high yield potential, Kera Chandra developed by CPCRI was recommended for release as a 'National variety' by the XII Biennial Workshop of the All India Coordinated Research Project on Palms during the year 1995, for commercial cultivation in the West Coast of the country including Konkan Region, coastal Andhra Pradesh and West Bengal.

Kalpa Pratibha

Kalpa Pratibha, developed as a selection from IND 016, Cochin China Tall (CCNT), is a high yielding dual-purpose variety (copra and tender nut variety). The palms are regular bearers and under rainfed conditions commence flowering about 6-7 years after planting in the field. The palms are tall in habit with a compact spherical canopy. The fruits are large, round in shape and predominantly green in colour. The seed nuts germinate faster with 50% nuts germinating in about 62 days after sowing. The variety produces an average of 98 nuts/palm/year.

The average weight of the fruit is around 1332g and from one fruit, on an average, 256.37g of copra (dried endosperm) can be obtained. The copra contains about 67% of oil. The oil extracted from the copra of this variety has 47.81% of lauric acid. The average quantity of tender nut water is 448 ml and the tender nut water is classified as "good" in taste. The nutritive value of tender nut water is as follows: total sugars - 5.5 g/100 ml; free amino acids - 1.1 mg/100 ml; Potassium - 2150 ppm; Sodium - 21.7 ppm.

The variety is relatively tolerant to drought. This variety gives an average yield of 4.07 tons copra/ha; 2.73 tons oil/ha; 15874 nuts/ha (under rain fed condition). The variety is found to be superior to the local control (WCT) and the estimated copra and oil yield per hectare is 40.11 % and 38.05 % higher than WCT, respectively. This high yielding variety will help enhance the coconut productivity in the country. This variety has the potential to produce on an average 23275 nuts, 5.97 tons of copra and 4.01 tons of oil per hectare.

The variety is recommended for cultivation in the states of Kerala, Andhra Pradesh, Tamil Nadu and Maharashtra. Based on its superior performance at CPCRI, Kasaragod in Coastal Kerala and AICRP on Palms Centres Ambajipeta in Andhra Pradesh, Veppankulam and Aliyarnagar in Tamil Nadu and Ratnagiri in Maharashtra, the XVIII Biennial Workshop of the All India Coordinated Research Project on Palms recommended the variety for commercial cultivation during the year 2007. This variety was subsequently released by Central Sub-committee on Crop Standards, Notification and Release of variety and notified vide Notification of Ministry of Agriculture (Department of Agriculture and Co-operation) S.O. 1714(E) dated July 18, 2008.

Kalpa Dhenu

Kalpa Dhenu, developed as a selection from IND 006, Andaman Giant Tall (AGT), is a high yielding and relatively drought tolerant variety. The palms are regular bearers and commence flowering 6-7 years after field planting, under rainfed conditions. The palms of this variety are tall and robust and appear gigantic. The fruits are large, oval in shape and green in colour. The time taken for 50% seed germination is about 99 days. The average yield of this variety is 3.66 tons copra/ha; 2.40 tons oil/ha; 15012 nuts/ha (under rain fed condition). The performance of this variety is found to be superior to the local control (WCT), with 26.07 % higher copra yield and 21.44 % higher oil yield as compared to WCT. This high yielding variety will help enhance the coconut productivity in the country. This variety has the potential to produce on an average 22794 nuts, 5.56 tons of copra and 3.64 tons of oil per hectare.

The average weight of the fruit is around 1381.26g and 256.37g of copra (dried endosperm) is obtained per fruit. The copra contains about 65.5% of oil. The oil extracted from the copra of this variety has 50.26% of lauric acid. The average quantity of tender nut water is 290ml. Based on the oraganoleptic test, the tender nut water is classified as “average” in taste. The nutritive value of tender nut water is as follows: total sugars -4.92 gil 00 ml; free amino acids -1.3 mg/l00 ml; Potassium -2650 ppm; Sodium -24.6 ppm.

The variety is recommended for cultivation in the states of Kerala, Tamil Nadu and the Andaman and Nicobar Islands. XVIII Biennial Workshop of the All India Coordinated Research Project on Palms recommended the variety for commercial cultivation during the year 2007, considering its superior performance at CPCRI, Kasaragod in Coastal Kerala and AICRPP Centre, Aliyarnagar, Tamil Nadu and Andaman and Nicobar Islands from where it was originally collected. Subsequently, Kalpa Dhenu was released and notified by the Central Sub-committee on Crop Standards, Notification and Release of variety vide Notification of Ministry of Agriculture (Department of Agriculture and Co-operation) S.O. 1714(E) dated July 18, 2008.

Kalpa Mitra

Kalpa Mitra, developed as a selection from IND 022, Java Tall (JVT), is a high yielding and relatively drought tolerant variety. The palms of this variety are tall in habit with stout trunk and spherical canopy with large number of leaves. The palms are regular

bearers and commence flowering 7-8 years after planting in the field, under rainfed cultivation. The fruits are large, oval in shape and yellowish green in colour. The seed nuts of this variety are slow to germinate with 50% nuts germinating in about 164 days after sowing. This variety gives an average yield of 3.37 tons copra/ha; 2.24 tons oil/ha; 13973 nuts/ha (under rain fed condition). The variety is found superior over local control (WCT) with an estimated 16.01 % and 13.45 % higher copra and oil yield than WCT, respectively. This high yielding variety will help enhance the coconut productivity in the country. This variety has the potential to produce on an average 22429 nuts, 5.41 tons of copra and 3.60 tons of oil per hectare.

The average weight of the fruit is 1001.19g and, on an average, 241.14g of copra (dried endosperm) per fruit can be obtained. The copra contains about 66.50% of oil. The oil extracted from the copra of this variety has 47.88% of lauric acid. The average quantity of tender nut water is 495ml. Based on the oraganoleptic test, the tender nut water is classified as “average” in taste. The nutritive value of tender nut water is: total sugars -5.7g/1 00 ml; free amino acids -1.3mgll00 ml; Potassium -2150ppm; Sodium 23.5ppm.

The variety is recommended for cultivation in the states of Kerala and West Bengal. The recommendation by the XVIII Biennial Workshop of All India Coordinated Research Project on Palms, in 2007, was based on the superior performance of this variety at CPCRI, Kasaragod in Coastal Kerala and

AICRP on Palms Centre Mondouri, West Bengal. The variety release proposal was approved by the Central Sub-committee on Crop Standards, Notification and Release of variety and this variety was released and notified vide Notification of Ministry of Agriculture (Department of Agriculture and Co-operation) S.O. 1714(E) dated July 18, 2008.

Kalpatharu

Kalpatharu is a high yielding variety, developed by selection of high yielding palms from Tiptur tall coconut population, a popular variety of Karnataka. The palms of this variety are tall with circular crown and are regular bearers and have an economic life span of up to 80 years, under favourable conditions. The average time taken for flowering in the population is about 6 years, under rain fed conditions. The shape of the fruit is oval with husked nuts being round in shape. This variety gave an average nut yield of 117 nuts/annum under rainfed conditions with an estimated annual copra and oil yield of 3.59 t/ha and 2.45 t/ha, respectively. The variety is relatively tolerant to drought and suitable for cultivation under both rainfed and irrigated conditions.

The average fruit weigh of this variety is around 958 g, with mean copra content of 172 g/ nut and oil content in copra of 67.2%. Approximately 5600-6800 nuts are required to make one tonne of copra. The oil contains about 44.7% of lauric acid. The quality of tender nut water is good in taste and the average quantity of tender nut water per nut is around 265 ml. The nutritive value of the tender nut water of Kalpatharu is as follows: total sugars – 5.0 g/100ml; free amino acids -2.9 mg/100ml; Potassium - 3200 ppm; Sodium - 60 ppm. The variety is especially suitable for ball copra production, as spoilage percentage (3.92%) during the process of ball copra production is lower as compared to other released varieties.

CPCRI is a participating institute in developing this variety, proposed for release by AICRPP Arsikere Centre. Kalpatharu was recommended for cultivation in the states of Karnataka, Tamil Nadu and Kerala by XIX Biennial Workshop of the All India Coordinated Research Project on Palms in 2009, based on the superior performance of this variety at AICRPP Arsikere Centre in Karnataka, CPCRI, Kasaragod in Coastal Kerala and AICRPP Centre Aliyarnagar inTamil Nadu. This variety has wider adaptability and would help in enhancing the productivity in the states of Karnataka, Tamil Nadu and Kerala.

Kera Keralam

This variety is developed as a selection from the accession IND 069, West Coast Tall (WCT). WCT is the common tall cultivar, extensively cultivated along the west coast regions of India. The palms are sturdy with compact spherical crown and yields economically for about 75 years or more. A fully grown palm of 27-30 years of age has an average of 36 functional leaves, with spherical or semi-spherical crown. The palms are regular bearers, annually producing about 12-13 inflorescences per palm. The WCT palms normally come to bearing in about 6-7 years, under rainfed conditions. However, under favourable conditions of irrigation and ample sunlight, early flowering within four years of planting has been recorded. The average annual yield under rainfed condition is 80 nuts per palm.

The fruits of the variety weigh about 800-900 g and have a copra content of 176 g/nut, with copra oil content of 68%. The oil of this cultivar contains 44.1 % lauric acid and is preferred for both edible purpose and soap manufacture. The nuts can also be used for preparation of ball copra, since only 9.09% spoilage is observed in this variety during the process of ball copra production. The husk of WCT is of good quality and extensively used for making coir and coir products. The palms of this variety also yield good quality and quantity of inflorescence sap, which can be converted into coconut palm jaggery or sugar.

The WCT palm grows well in all types of soil and is comparatively drought tolerant. Based on the superior performance of the WCT accession provided from CPCRI to AICRP on Palm centres at Aliyarnagar, Ambajipeta, Ratnagiri, Arsikere, the XVIII Biennial Workshop of the All India Coordinated Research Project on Palms during the year 2007 recommended the variety Kera Keralam for large scale commercial cultivation in the states of Tamil Nadu, Andhra Pradesh, Maharashtra, Kerala and Karnataka. The variety was subsequently released by the Central Sub-committee on Crop Standards, Notification and Release for cultivation in the states of Tamil Nadu, Andhra Pradesh, Maharashtra, Kerala and Karnataka and notified in the gazette of India vide Notification of Ministry of Agriculture (Department of Agriculture and Co-operation) S.O. 1979(E) dated August 12, 2010.

Kalpa Haritha

Kalpa Haritha variety is derived from the CPCRI coconut accession IND045, Kulasekharam Green Dwarf (KGD) that was collected from Kulasekharam,

Tamil Nadu and conserved at CPCRI. The variety was evaluated under rainfed conditions for over 50 years and the present selection was made for better performance in terms of yield and tender nut traits. The proposed variety gives an average nut yield of about 118 nuts per palm per year, 3.72t/ha copra and 2.47 t/ha oil under rainfed conditions. The variety gives 48 % more nuts per palm per year, 54 % more copra out turn and over 50 % more oil yield per hectare than the local check West Coast Tall under rainfed conditions

The palms are tall with slight bole at the base and attain an average height of 13.8 m in 50 years after planting. The colour of the petiole is green. The variety bears green coloured, oval fruits and the dehusked fruits are round in shape. The seedlings are vigorous, with green coloured petiole and an one year old seedling, produces on an average about 9 leaves with collar girth of over 17 cm and average height over 160 cm. The palms are regular bearers and commence flowering 45 months after planting under rain fed conditions. The average time taken for flowering of 50% of the palms in the population is 50 months. No major pest attacks and disease out breaks is observed under field conditions. The palms of this Kalpa Haritha are relatively tolerant to eriophyid mite attack and recorded lesser incidence of eriophyid mite amidst heavy infestation on other palms in the vicinity.

The average quantity of tender nut water is about 440ml. Based on the organoleptic test; the tender nut water is classified as “very good” in taste with a TSS of 5.850 Brix. The tender nut water has Na content of 17.5 ppm and K content of 2100 ppm. The average fruit weight of Kalpa Haritha variety is 914 g, with copra content of 216 g/nut, with copra oil content of 66.5%.

Kalpa Haritha variety has been categorized as relatively tolerant to moisture stress as the palms are high yielding under rainfed conditions when compared to the local check WCT. The variety Kalpa Haritha has distinguishable characters of medium category with respect to time taken for inflorescence emergence, medium inflorescence length, many number of female flowers per inflorescence, medium duration of female phase, presence of intra spadix overlapping of male and female phases, oval fruit shape and thin endosperm. About 10 % variability is expected due to the inherent heterozygosity of the crop and hence, seedling selection is to be followed. This variety is propagated through seeds. Controlled

pollination between the selected parental palms followed by seedling progeny selection is to be followed.

Based on the superior performance of this variety at CPCRI, Kasaragod in coastal Kerala (in sandy loam soil) and CPCRI Research centre, Kidu, Karnataka (in laterite soil), the XXI Biennial Workshop of the All India Coordinated Research Project on Palms during the year 2012 recommended the variety Kalpa Haritha for large scale commercial cultivation in the Coconut growing tracts of Kerala and Karnataka states.

This superior high yielding variety will help in enhancing the coconut productivity as it has the potential to yield 36350 nuts per ha which will provide 6.56 tons copra per ha, yielding upto 4.3 tons oil per ha.

Kalpa Shatabdi

This variety is developed as a selection from the accession IND 034, San Ramon Tall (SNRT). SNRT is the introduced tall cultivar from Philippines in 1955. SNRT is the tall cultivar, with spherical canopy and slight bole at base with closely arranged leaf scars. The palms normally come to flowering 72 months after planting, under the rain fed conditions. It is a high yielding, dual purpose variety; with large attractive greenish yellow fruits weigh about 1965 g, suitable for copra and tender nut production. It gives greater volume (612 ml) of good quality tender nut water and has a copra content of 272.9 g/nut with copra oil content of 64%. It is unsuitable for ball copra production due to early germinating nature of the fruits. This variety shows lesser incidence of rhinoceros beetle damage. Based on the superior performance of the SNRT accession, ICAR- CPCRI Centenary year, XXV AICRP Group meeting-2016 recommended the variety Kalpa Shatabdi for large scale commercial cultivation in the states of Kerala, Karnataka and Tamil Nadu. ■